Music Therapy for People with Cerebral Palsy: A systematic Review

Puchong Chimpiboon[1]
Music Therapy Department
College of Music, Mahidol University
Email: puchongmsmu@gmail.com

Abstract

This study aimed to synthesize research studies in music therapy for people with cerebral palsy. Nineteen quantitative research studies met the selection criteria which were collected from electronic databases including PubMed, CHINAHL, ERIC, ThaiLIS, and ProQuest. A coding form, consisting of a) publications and researchers, b) research methodology, and c) research content and music intervention, was developed as a research instrument for collecting the characteristics data from these research studies. Descriptive statistics (frequency and percentages) were used to analyse the data and describe the research findings.

Result of synthesis showed that articles (84.2%) was the largest number of research studies, and were published via journals in the field of medicine (57.9%) during 2011 - 2015 (52.6%). Single-case study, one group pretest-posttest, and randomized control group pretest-posttest were equally used as research design at 21.1%. Participants in the research studies were mainly diagnosed as Spasticity (26.3%) in adolescence to early adulthood (21.1%). In terms of research contents and music intervention, Neurological Music Therapy (NMT) was the most widely used theory for developing the music intervention (42.1%). Music movement was the most popularly used (52.6%). Songs were most commonly selected by researcher based on assessment (42.1%). Audio equipment was mostly used as the music instruments or materials (25%). In respect of the number of sessions and the duration of time, the music intervention was given to participants only one time (26.3%) for 30 minutes mostly (36.8%). The outcomes were largely in the area of physical development (63.2%) such as gait, fine motor, gross motor,

and step cadence. Regarding the testing results, most of the research findings were based on the hypothesis (26.3%).

Keywords: Music Therapy, Cerebral Palsy, Systematic Review

[1]Master' s degree student, Music Therapy Department

ดนตรีบำบัดสำหรับผู้ป่วยสมองพิการ: การสังเคราะห์งานวิจัย

ภุชงค์ ฉิมพิบูลย์[1]
สาขาวิชาดนตรีบำบัด วิทยาลัยดุริยางคศิลป์ มหาวิทยาลัยมหิดล
Email: puchongmsmu@gmail.com

บทคัดย่อ

วัตถุประสงค์ของการวิจัยในครั้งนี้คือ เพื่อสังเคราะห์งานวิจัยด้านดนตรีสำหรับผู้ป่วยสมองพิการ มีงานวิจัยจำนวน 19 เล่ม ที่มีความสอดคล้องกับเกณฑ์ที่ผู้วิจัยได้ตั้งไว้ จากการสืบค้นในฐานข้อมูลต่างๆ ประกอบด้วย PubMed, CHINAHL, ERIC, ThaiLIS, และ ProQuest เครื่องมือที่ใช้ในงานวิจัยในครั้งนี้คือแบบบันทึกคุณลักษณะของงานวิจัย เพื่อใช้เก็บรวบรวมข้อมูลใน 3 ประเด็น ได้แก่ การตีพิมพ์และผู้วิจัย ระเบียบวิธีวิจัย และเนื้อหางานวิจัยและการใช้ดนตรี สถิติที่ใช้ในการวิเคราะห์ข้อมูลคือสถิติเชิงบรรยาย โดยทำการวิเคราะห์ความถี่และร้อยละของคุณลักษณะของงานวิจัยในแต่ละประเด็น

ผลการวิจัยพบว่า งานวิจัยส่วนใหญ่เป็นบทความวิจัย (ร้อยละ84.2) ซึ่งตีพิมพ์ในวารสารด้านการแพทย์ (ร้อยละ 57.9) และตีพิมพ์ในช่วงปี ค.ศ.2011-2015 (ร้อยละ 52.6) ระเบียบวิธีวิจัยที่ใช้มากที่สุดคือ Single-case study, One group pretest-posttest, และ Randomized control group pretest-posttest (ร้อยละ 21.1) ผู้เข้าร่วมการวิจัยส่วนใหญ่ได้รับการวินิจฉัยเป็นโรคสมองพิการชนิดเกร็ง (ร้อยละ 26.3) อยู่ในช่วงวัยรุ่นถึงวัยผู้ใหญ่ช่วงแรก (ร้อยละ 21.1) สำหรับด้านการใช้ดนตรี พบว่า ทฤษฎีที่นำมาใช้พัฒนาดนตรีสำหรับการทดลองมากที่สุดคือ Neurologic Music Therapy (ร้อยละ 42.1) กิจกรรมทางดนตรีที่ใช้มากที่สุดคือการเคลื่อนไหวประกอบเพลง (ร้อยละ 52.6) ดนตรีที่ใช้ในการทดลองส่วนใหญ่ทำการคัดเลือกโดยนักวิจัยจากผลของการประเมินในขั้นต้น (ร้อยละ 42.1) สำหรับอุปกรณ์ที่ใช้มากที่สุดในการบำบัดคืออุปกรณ์อิเล็กทรอนิกส์ (ร้อยละ 25) เมื่อพิจารณาด้านระยะเวลาในการรับการบำบัด พบว่า ส่วนใหญ่ผู้เข้าร่วมการวิจัยจะได้รับกิจกรรมดนตรี 1 ครั้ง (ร้อยละ 26.3) ครั้งละ 30 นาที (ร้อยละ 36.8) เมื่อพิจารณาผลของการวิจัยจำแนกตามพัฒนาการ พบว่า โดยส่วนมากเป็นทางด้านกายภาพ (ร้อยละ 63.2) และผลการวิจัยส่วนใหญ่เป็นไปตามสมมติฐาน (ร้อยละ 26.3)

คำสำคัญ : ดนตรีบำบัด, สมองพิการ, การสังเคราะห์งานวิจัย

[1]นักศึกษาปริญญาโท สาขาวิชาดนตรีบำบัด วิทยาลัยดุริยางคศิลป์ มหาวิทยาลัยมหิดล

Introduction

Cerebral palsy is a neurological disorder caused by a non-progressive brain injury that occurred in the period of infancy, early childhood, or permanently. The primary effects or developmental defect of cerebral palsy are both of body movement and muscle coordination. The cause of cerebral palsy is brain damage before birth (Prenatal period), during pregnancy, childbirth, or after. The brain can be damaged because of metabolic disease, Rh incompatibility, anoxia (oxygen shortage), or an illness or infection of the mother such as rubella, toxoplasmosis in pregnancy period. During childbirth, the brain can be damaged because of premature birth, and anoxia. As to the after birth period, children might encounter head trauma, choking, poisoning, or tumor (National Institute of Neurological Disorders and Stroke, 2014). The early signs of cerebral palsy usually occur before the age of three years. The common signs are a lack of muscle coordination, stiff or tight muscles, exaggerated reflexes, walking with one foot or leg dragging, walking on the toes, a crouched gait, and muscle tone that is either too stiff or too floppy. Brain damage has an impact on physical development such as moving, walking, eating, seeing, hearing, or communication depending on the part of the brain (Sankar & Mundkur, 2005; Rethlefsen, Ryan, & Kay, 2010; & National Institute of Neurological Disorder and Stroke, 2015).

The incidence of cerebral palsy in the western world is 2 children in 1,000 new born babies (International Cerebral Palsy Society, 2008). The investigation of the Centers for Disease Control and Prevention or C.D.C. (2015) reported that there was 1 in 323 children diagnosed with cerebral palsy. The average prevalence of cerebral palsy in the United States in 2004 was 3.3 per 1,000 people and was significantly higher in males than females (Arneson et al, 2004). In Thailand, Srijantongsiri (2006) found that, in 2003, there were 296 children (male 58.1%, female 41.9%) who were patients at the Queen Sirikit National Institute of Child Health diagnosed with cerebral palsy. The major type was spastic quadriplegia which is inabilities to walk independently and the main causes were perinatal asphyxia, and infection. Additionally, her study found that there were associated morbidity consisting of epilepsy, macrocephaly,

hearing loss, mental retardation, and blindness.

Treatment and care of children with cerebral palsy is determined by the severity of the diagnosis and condition. Relevant treatments may include pharmacological (drug) or mechanical interventions, surgery and various therapies. Both surgery and mechanical aids help to overcome impairments, including orthopedic surgeries for adjusting tendon or joints. Therapies for children with cerebral palsy include physical therapy, occupational therapy, speech therapy, and music therapy which may improve functional capabilities of children, (Patel, 2005; Hansakunachai, 2011). Previous studies indicated that music therapy has an impact on gait training, developing communication skills, and creating new neural tracts (Kwak, 2007; Perry, 2003).

Music therapy provides benefits for people with cerebral palsy. Music therapy is the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program (American Music Therapy Association, 2014). According to published findings, using music and music therapy with cerebral palsy patients positively affects both mental and physical development of patients with CP. A study conducted by Yu, Liu, Li, & Ma (2009) indicated that using music for children with cerebral palsy reduced anxiety while receiving acupuncture, and improved creeping, kneeling, standing and walking. In 2007, Kwak found improved gait performance, velocity and stride length with the use of music, and Kho (2011) found improved communication and social skill.

Cerebral palsy involves with the brain, and music also affects the brain. Therefore, music has potential for application in clinical work. Many studies have demonstrated the effectiveness of using music on the brain. The study of Stewart, Kriegstein, Warren, and Griffiths (2006) reviewed many research evidences from basic and clinical neuroscience. Their review reported that music listening involved many cognitive components with distinct brain substrates. Hyde et al. (2009) compared structural brain development between children in musical training or playing music instruments and children in

control condition. This comparison showed that children in the musical training group had greater changes in motor brain areas such as the right precentral gyrus (motor hand area), the corpus callosum (midbody), and the right primary auditory region (Heschl's gyrus). In addition, the differences of brain deformation were found in various frontal areas, in the left posterior peri-cingulate, and a left middle occipital region in children in the musical training group. Therefore, brain plasticity is affected in brain regions that control primary functions because of playing music instruments. In terms of the effect of music on the brain with cerebral palsy, the study of Orita, Hayashida, and Shinkawa (2012) found that using music therapy with children with disabilities including cerebral palsy, showed a significant change in parasympathetic nervous activities. The parasympathetic nervous system is one type of autonomic nervous systems which has an effect on several physiological processes such as decreasing heart rate, constricting the bronchial tubes in the lungs and pupils in the eyes, relaxing muscles, enhancing saliva production, and increasing the urinary output and sphincter relaxation. Stegemoller (2014) explained that using music therapy increased dopamine, which was a neurotransmitter in the brain that is involved in motivation and reward-seeking behavior, working memory, and reinforcement learning. Music stimulated the activation of dopaminergic regions of the brain in order to provide motivation, reward, and learning. Therefore in the music therapy clinic, the target behaviors were improved by using music as the reward and motivation for the completion of target behaviors.

While there is some research literature that addresses the outcomes and benefits of music therapy for individuals with cerebral palsy, there are very few large-scale studies that discuss results that could be generalized to the wider population. Furthermore, there is currently no compilation of research related to music therapy and treatment of individuals with cerebral palsy. A systematic review is one type of research methodology used in health care and medicine to locate, appraise, and synthesize the research evidence based on a clearly formulated question to provide informative answers for work in clinical practice, research, or policy (Boland, Cherry, & Dickson, 2013; Hanson-Abromeit & Moore, 2014).

Furthermore, systematic reviews help clinicians understand the current research findings and make an appropriate choice of treatment by summarising the evidence. Systematic reviews give a clear and consistent picture of research (Boland, Cherry, & Dickson, 2013).

In recent years, music therapy researchers have used the systematic review as a way to sumarize and analyze research literature with many populations. Engwell and Duppils (2009) synthesized research in the field of using music as a nursing intervention for post-operative pain. Wong, Chan, and Thayala, (2010) conducted a systematic review of the effectiveness of music listening in reducing depressive symptoms in adults. In 2011, Anderson, did a systematic review in the area of hospice and palliative care, and Naylor, Kingsnorth, Lamont, McKeever, and Macarthur, (2011) analyzed the research regarding effectiveness of music in pediatric health care.

As mentioned above, there have been many systematic review research in the field of music therapy with different populations, but no systematic review research in the field of music for cerebral palsy. Therefore, it is of value to systhesize research in the field of music for people with cerebral plasy in order to fullfill the evidence based in the area of the music therapy clinic.

The value of this study is the music therapy evidence base which benefits music therapists or clinicians in selecting music intervention for clients effectively. This research will reveal the wide extent of studies in this field.

Purpose of the Study

The purpose of this study was to synthesize research in music therapy for people with cerebral palsy. Three main characteristics were analysed, comprising 1) publications and researchers, 2) research methodology, and 3) research content and music intervention.

Research Methodology

A systematic review was employed in this study in order to address the aims of the study which was to synthesize music research in the field of music intervention for people with cerebral palsy. The process of doing a systematic review in this study including

(1) Determining the review research question and purpose, scope of searching, and writing protocol, (2) Collecting the

data by searching the studies that relate to the research question, and selecting the full-text papers, (3) Identifying selection criteria, (4) Extracting the data, (5) Developing the coding form and test inter-rater reliability, (6) Coding the data by reading the full-text paper, and analyzing data by the using SPSS program, and (7) Reporting the data.

In this study, three main characteristics were analysed: (1) publications and researchers, (2) research methodology, and (3) research content and music intervention.

Search Strategy

All data were collected by a comprehensive search via the electronic databases: PubMed, CINAHL, ERIC, ThaiLIS, and ProQuest. In addition, the studies were collected from electronic journals: the Arts in Psychotherapy, Australian Journal of Music Therapy, Journal of Music Therapy, Music and Medicine, Canadian Journal of Music Therapy, Qualitative Inquiries in Music Therapy, and Nordic Journal of Music Therapy.

Selection Criteria

The research studies were included based on selection criteria including (1) only quantitative research design was included in this study, (2) the research study was in the field of music for people with cerebral palsy, (3) the participants in the study were diagnosed as having cerebral palsy with no restrictions as to age, gender, type of cerebral palsy, and setting, (4) the use of music as intervention was reported, and (5) the result of the study reported nonmusical goals such as cognition, physiology, communication, social, and psychology.

Research Instrument and Inter-rater Reliability

To address the purpose of this study, a coding form was developed as the research instrument. It was developed by using documents, text-books, articles, and research relevant to this study. The coding form consists of twenty four items within three main topics including 1) publications and researchers, 2) research methodology, and 3) research content and music intervention.

To test the reliability of the coding form, inter-rater reliability was used as a method of testing in this study. This was done by analysing the correlation of coding scores between two people, including researcher and expert. Pearson Product

Movement Correlation was used to test consistency of the result of coding form between researcher and expert. Inter-rater reliability produced a strongly significant correlation (r = .997, p = .01). This demonstrated the high agreement of both researcher and expert.

Data Collection and Analysis

1) Collecting research studies that involve using music for people with cerebral palsy via electronic databases and electronic journals.

2) Selecting research studies which met the selection criteria by reading the topic and abstract.

3) Reading full text research studies and completing the coding form.

4) Transferring the data from coding form to SPSS program for the analysing process. Analysing the data by using SPSS program and descriptive statistics including frequency and percentage.

Results

There were 43 research studies found from searching process; however, only 19 research studies met the selection criteria. 24 studies did not meet the criteria because of being qualitative research design (25%), reporting musical goals (4.2%), missing information about music intervention (25%), using non-music intervention such as intensive voice treatment (12.5%), being a theoretical paper (29.1%), and including participants with cerebral palsy and other diagnoses which did not report the result separately (4.2%). Detail shown in figure 1.

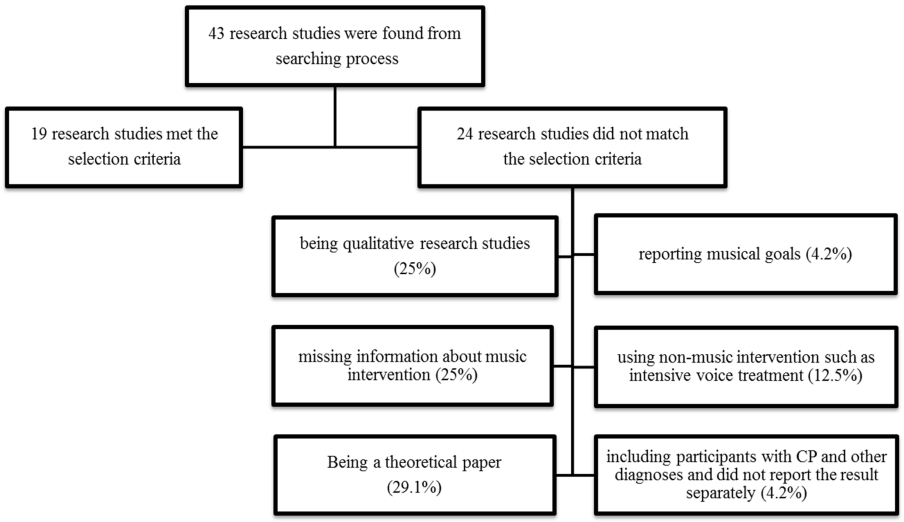

Figure 1: Number of research studies in the searching process

The detail of nineteen research studies are presented in table 1 which included authors, year of publication, name of journal, experimental research design, sample size, age of participants, type of Cerebral Palsy, music intervention, outcomes, assessment tools, and result.

Table 1 Detail of research studies

REF	Author/Year/ Name of Journal	Experimental research design	Sample size	Age/Type of CP	Music intervention	Outcomes	Assessment tools	Result
001	Yu et al. / 2009/ Journal of Traditional Chinese Medicine	Randomized control-group pretest-posttest design	60	Late Childhood - Adolescence (7 – 18 years old)/ Spasticity, & Flaccid	Listen to nursery songs or rhymes during acupuncture treatment for 30 minutes and play music instruments after acupuncture treatment for 30 minutes.	Clinical therapeutic effects	1. Comprehensive Functional Assessment Chart for Children with CP 2. Gross Motor Function Measure (GMFM)	1. Significant in creeping, kneeling, standing and walking skills ($P<0.01$). 2. Not Significant in the improvement of turning the body over from the prone position and in the functional aspects in sitting position ($P>0.05$)
002	Kima et al. / 2011/ NeuroRehabilitation	Pretest-Posttest Design with Nonequivalent Groups	14	Adolescence - Early adulthood(13 – 40 years old)/ Spastic Diplegia	Rhythmic Auditory Stimulation (RAS).	Gait pattern	1. Three-dimensional (3D) kinematic recordings 2. Six-camera Vicon 370 Motion Analysis system (Oxford Metrics Inc., OxOxford, U.K.) 3. Gait Deviation Index (GDI) 4. Temporospatial parameters	Significant at .05 in; • the pelvis, the maximal angle • the minimal angle of anterior tilt of pelvis • the sagittal plane, angles of maximal and minimal hip flexion • the transverse plane, external rotation of the hip joint at initial contact • the anterior tilt of pelvis at initial contact • the maximal hip flexion angle in the sagittal plane • the minimal angle of anterior • tilt of pelvis • the household ambulators

REF	Author/Year/ Name of Journal	Experimental research design	Sample size	Age/Type of CP	Music intervention	Outcomes	Assessment tools	Result
								Not significant at .05 in; • the kinematic results of the knee, ankle, and foot • the community ambulators • walking velocity, step length, step time, single limb support, double limb support, stance phase, or swing phase
003	Kim et al./ 2012/ Clinical rehabilitation	Randomized control-group pretest-posttest designs	28	Early adulthood (19 – 40 years old)/ Bilateral spasticity	Rhythmic Auditory Stimulation (RAS).	Gait pattern	1. Six-camera Vicon 370 Motion Analysis system (Oxford Metrics Inc, Oxford, UK) 2. Temporal parameters	Significant at .05 in ; • cadence, walking velocity, stride length and step length • internal and external rotations of hip joints • stride time and step time were significantly improved • anterior tilt of the pelvis and hip flexion during a gait cycle
004	Varsamis et al./ 2012/ International Journal of Special Education	One group pretest - posttest design	4	Adolescence - Early adulthood(13 – 40 years old)/ Mild Spastic, Etraplegia	Rhythmic Auditory Stimulation (RAS).	Controlling stepping cadence	OEMMEBI Profitness device	• decreased cadence, and increased training duration, • kept their heart rate between the aerobic exercise decreased intra-individual standard deviations in both cadence and heart rate per minute.

REF	Author/Year/ Name of Journal	Experimental research design	Sample size	Age/Type of CP	Music intervention	Outcomes	Assessment tools	Result
005	Kwak/ 2007/ Journal of Music Therapy	Pretest-Posttest Design with Nonequivalent Groups	25	Early childhood - Early adulthood (3 – 40 years old)/ Spastic	Rhythmic Auditory Stimulation (RAS).	Gait performance	Stride Analyzer.	The RAS as therapist-guided training showed more significant difference in stride length, velocity, and symmetry ($p<.05$) than self- guided training.
006	Francis/ 2011/ International Journal of Therapy and Rehabilitation	Single case design	2	Late Childhood - Early adulthood (7 – 40 years old)/ Not specify	Listen to recorded music	Behavioral outcome in 1. attention, concentration and engagement, 2. anxiety	1. Video recording for mood and attention 2. Observational recording: ● Positive/calm responses ● Negative/anxious responses ● Listening/engaged behaviour ● Distracted/not sure. 3. The Profound Education Curriculum (St.Margaret's School 2009) 4. Questionnaire from family, teaching, therapy and care staff	1. Attention to task and person engagement were changed positively 2. Mood was improved when listening to music

REF	Author/Year/ Name of Journal	Experimental research design	Sample size	Age/Type of CP	Music intervention	Outcomes	Assessment tools	Result
	2009/ International Journal of Nursing Studies	control-group pretest-posttest designs		Childhood (0 – 12 years old)/ Many types of C.P. such as Spastic, Dyskinetic, other	music		anxiety 2. CHEOPS for measuring pain 3. FACES for measuring pain 4. Mean arterial blood pressure (MAP) 5. heart rate (HR) 6. respiratory rate (RR)	• anxiety • pain • Mean arterial blood pressure (MAP), • heart rate (HR) No significant at .05 in • respiratory rate (RR)
008	Chong et al./ 2013/ Journal of Exercise Rehabilitation	One group pretest - posttest design	5	Adolescence - Early adulthood(13 – 40 years old)/ Spastic, Dyskinetic	Therapeutic Instrument Music Performance (TIMP)	Hand function	Music Instrument Digital Interface (MIDI) of key pressing force.	1. Improved hand function 2. Improved manual dexterity and velocity of finger movement 3. all five fingers were improved, and the biggest improvement was found in fourth finger
009	Peng et al./ 2011/ Gait & Posture	One group pretest - posttest design	23	Early childhood - Late Childhood (3 – 12 years old)/ Spastic Diplegia	Patterned sensory enhancement (PSE) music	Movement control in Load sit-to-stand movement	The Normalized Jerk Index (NJI)	Load sit-to-stand was improved in music condition
010	Orita et al./ 2012/ Tohoku Journal Exp. Med.	One group pretest - posttest time-series design	3	Adolescence - Early adulthood(13 – 40 years old)/ Not specify	Listen to Piano Playing for 50 Minutes	1.Parasympathetic activity 2.Sympathetic activity 3.Heart rate or HR	Electrocardiography	• Significant at .01 in Parasympathetic activity and Heart rate • Not significant at .01 in Sympathetic activity

REF	Author/Year/ Name of Journal	Experimental research design	Sample size	Age/Type of CP	Music intervention	Outcomes	Assessment tools	Result
012	Ahonen-Eerikäinen et al./ 2008/ The International Journal of Psychosocial Rehabilitation	Case study design	6	Early childhood - Late Childhood (3 – 12 years old)/ Not specified	Virtual Music Instrument (VMI)	Enhancing Participation and Restoring Self-Image	1. Video Observation 2. Clinician Notes	1. Enhanced full body participation, restored self-images and express feelings. Provided a sense of relationship 2. Reduced tension and anxiety in sharing experiences. 3. Offered the potential for positive, reinforced musical experiences.
013	Perry/ 2003/ Journal of Music Therapy	Case study design	7	Late Childhood (7 – 12 years old)/ Spastic	Selected Improvisation technique (Rainey Perry, 1999)	Communication	1. Video Recording 2. Communication profile (Raincy Perry, 1999)	The communicational skills of participants were developed in the areas of turn taking, attention, and engagement in the interaction.
014	Wolfe/ 1980/ Journal of Music Therapy	Single case design	12	Early childhood - Early adulthood (3 – 40 years old)/ Spastic	Listen to recorded music	Head Posturing	Mercury switch head device	Head control was improved during music condition.
015	Jiang/ 2013/ Master thesis from the University of Miami	One group pretest - posttest time-series design	9	Early childhood - Late Childhood (3 – 12 years old)/ Spastic	Rhythmic Auditory Stimulation (RAS).	Gait	1. Gross Motor Function Classification System (GMFCS) 2. Gait parameters.	1.Increase velocity, cadence, and stride length • 2. Improved walking speed and taking longer steps.

REF	Author/Year/ Name of Journal	Experimental research design	Sample size	Age/Type of CP	Music intervention	Outcomes	Assessment tools	Result
016.	Krakouer et al./ 2001/ International Journal of Psychosocial Rehabilitation.	Single case design	5	Early adulthood - Middle age (19 – 60 years old)/ Not specify	Music intervention was served for 45 minutes including; 1. Live music listening for relaxation 2. Active music activities to stimulate participation 3. Music instrument playing for enhancing individual goals	Individual target behavior changes in; 1. Hand movement 2. Striking action 3. Sitting posture 4. Feet movement 5. Eye contact	1.VDO recording 2. Behavioral observation	All of individual target behaviors were changed positively after receiving music intervention.
017	Tindal/ 2011/ Master thesis from Arizona State University	Single case design	1	Early adulthood (19 – 40 years old)/ Spastic Diplegia	Recorded Rhythmic Music Accompanied by Audible drum beat 1. Pre-gait training check-in or discussion and talking for (15 minutes) 2. Stretching (5 minutes). 3. Gait training (15-20 minutes) 4. Stretching (5 minutes) 5. Post gait training and relaxation (15-20 minutes)	Walking gait including; 1. endurance 2. cadence 3. velocity 4. emotional responsiveness 5. motivation	1. Viedo tape recording 2. Subject and researcher journals 3. A quantitative emotional responsiveness checklist 4. Interview	1. Increased endurance, cadence, and velocity 2. Improves positive emotion and motivation
018	Johansson et al./	One group pretest	3	Adolescence (13	Synchronized	Motor timing,	1.Applied SMT training	1. Improved motor timing

REF	Author/Year/ Name of Journal	Experimental research design	Sample size	Age/Type of CP	Music intervention	Outcomes	Assessment tools	Result
	2014/ Clinical Case Study	- posttest design		– 18 years old)/ Diplegic C.P.	Metronome Training	spatio-temporal movement organization, and upper-limb function	equipment 2.Optoelectronic registrations 3.A questionnaire for assessing subjective experiences of changes in upper-limb functions and usability 4.Three-dimensional (3D) kinematic	2. Changed spatio-temporal movement positively 3. Increased movement control and reduced muscle tone 4. Made smoother and faster movement 5. Improved upper-limb kinetics 6. Improved functionality of hands/arms
019	Scartelli/ 1982 / Journal of Music Therapy	Randomized control-group pretest-posttest designs	6	Early adulthood (19 – 40 years old)/ Spastic	Sedative music-assisted EMG biofeedback relaxation training	Muscle tension	Biofeedback mechanism	Decreased muscle tension

Three main characteristics were synthesized consisting of publications and researchers, research methodology, and research content and music intervention.

1. Publications and Researchers

The results of research characteristics in publications and researchers revealed that most of the studies were published during 2011-2015 (52.6%), followed by 2006-2010 (26.3%), and 2001-2005 (10.5%). Detail of year of publication shown in figure 2. Regarding types of the studies, most studies were research articles (84.2%) and Master Dissertation or Thesis (15.8%). In terms of publication sources, most research studies were published in journals in the field of medicine (57.9%), followed by journals in the field of music therapy (21.1%). Only one article was published in a journal in the field of special education (5.2%). Mostly, research studies were conducted by researchers who received master's degrees (15.8%). However, most research studies did not report the academic qualifications of researchers (63.2%).

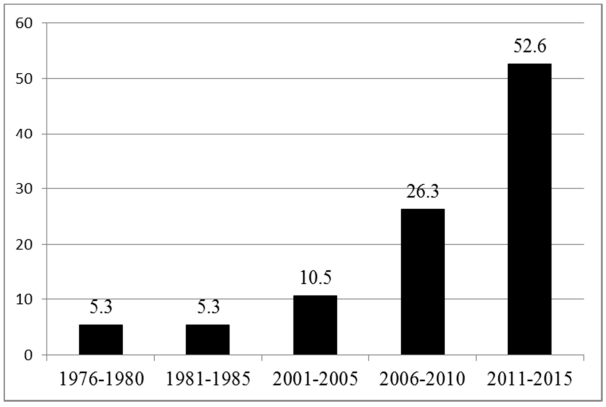

Figure 2: Detail of year of publication

2. Research Methodology

In terms of research methodology, the result included experimental research design, sample size, selection of participants, and assessment tools. The result of the experimental research design showed that one group pretest - posttest design, randomized control-group pretest-posttest designs, and single case study designs were equally frequently and

conducted most (21.1%), followed by case study designs (15.7%), and one group pretest - posttest time-series design, and pretest-posttest design with nonequivalent groups (10.5%).Detail of research design shown in figure 3. The sample size indicated that the most common number of participants was one to five, and six to ten (26.3%), followed by eleven to fifteen (15.8%). The lowest number of participants were sixteen to twenty, and twenty six to thirty (5.3%) used equally often. Participants were selected by different selection criteria consisting of purposive selection assignment, random assignment, combined random selection and random assignment. The most common selecting method was purposive selection (78.9%), followed by random selection and assignment (10.5%), and random selection (5.3%).

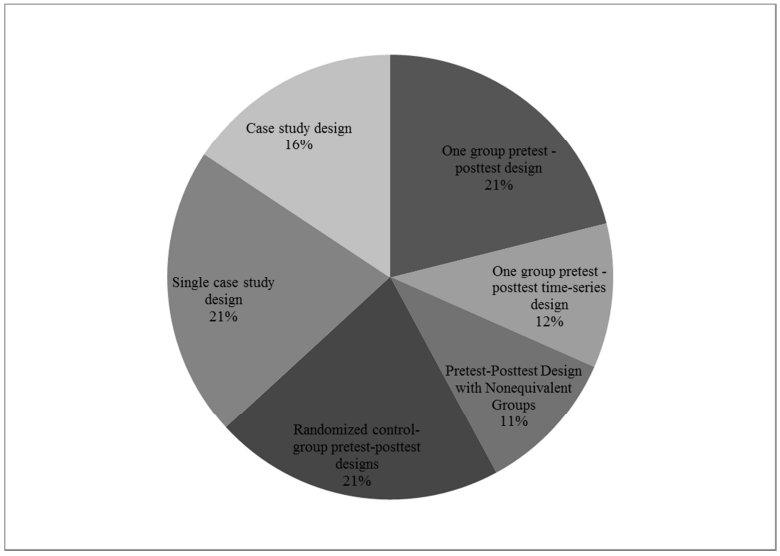

Figure 3: Detail of research design

There were 27 assessment tools used in 19 research studies. They were classified based on the purposes of measurement tools into five types including physical measurement, emotional measurement, pain measurement, communicational measurement, and other measurement such as video, questionnaire, check list, and field note. The assessment tools most often used were to measure physical development (61.5%). The others assessment tools such as video, questionnaire, check list, and field note, were often used (19.2%). The example of assessment tools such as Gross Motor Function Measure (GMFM), Vicon 370 Motion Analysis system, Gait deviation index (GDI) , Anxiety Scale (mYPAS), Children's Hospital of Eastern Ontario Pain Scale (CHEOPS), Wong-Baker FACES Pain Rating Scale (FACES), and Communication profile.

3. Research Content and Music Intervention

The result in the area of research content and music intervention included types of cerebral palsy, age of participants, outcomes as developmental domains, type of outcome, testing results, and music intervention.

In type of participant, the result revealed that mostly participants who were diagnosed with spasticity participated in the study (26.3%), followed by spastic diplegia, bilateral spasticity, and many types or not limited types such as spastic, dyskinetic (10.5%). However, five research studies did not identify type of cerebral palsy (26.3%). Most participants in the studies were in the age of adolescence - early adulthood or 13 – 40 years old (21.1%), followed by early childhood - late childhood or 3 – 12 years old, early adulthood or 19 – 40 years old (15.8%), and early childhood – early adulthood or 3 – 40 years old (10.5%).

With regard to outcomes as developmental domains, the result demonstrated that physical development was the most popular outcome (63.2%), followed by cognition, and both physical and social development (10.5%), and communication, emotion, and both social and communicational development (5.3%). Detail shown in figure 4. In terms of type of outcome, the most common type was gait (15.8%), followed by step cadence and

heart rate, and engagement and kinesthetic (10.5%).

According to the results of nineteen research studies, most of the results were based on the hypothesis (26.3%), followed by significant all variables at .05, significant some variables at .05, and significant all variables but NOT reporting P-Value (15.8%).

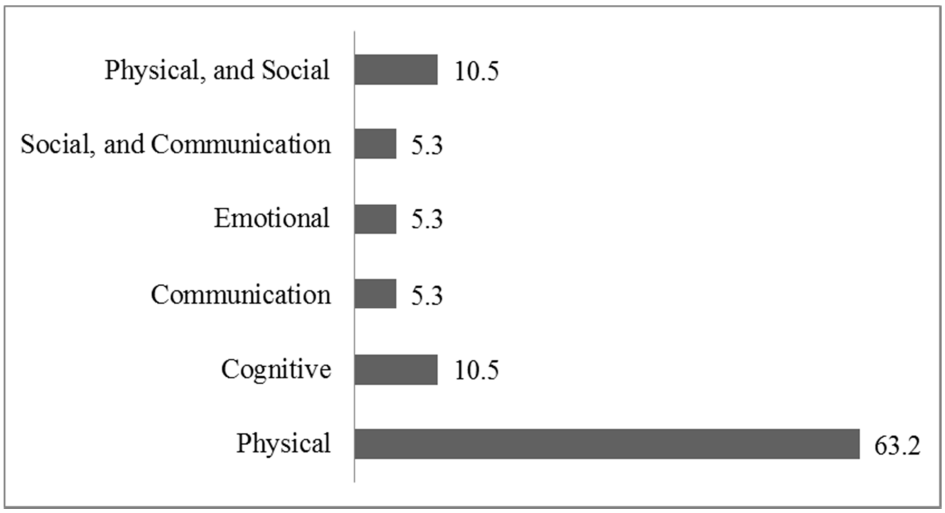

Figure 4: Detail of outcome as developmental domain

With regard to music intervention, eight characteristics were explained, consisting of intervention theory/ principle, intervention strategy/music activity, music selection process, music delivery method, music instrument/materials, number of sessions, duration of each session, and frequency of sessions.

The most common of intervention theory was Neurologic Music Therapy or NMT (42.1%), followed by Procedure Support, (10.5%), and Auditory Processing Theories of a French ENT Surgeon, Improvisational Technique, Electromyographic (EMG) Biofeedback (5.3%). Six research studies did not report intervention theory (31.6%).

Regarding music used, music movement was most used as the intervention strategy (52.6%), followed by music listening (15.8%), and combined music listening and playing music

instruments. Music was selected by researcher mainly based on assessment (42.1%), followed by pre-selected by researcher (31.6%). A few research studies reported that music was developed based on theory, composed, and pre-composed by researchers; music also was selected from their own collection, and limited set (5.3%). Most common music delivery methods were live music and recorded music, used equally (47.4%). Audio equipment was occasionally used as music instrument or materials (25%), such as mp.3 player, computer sound system, cassette tapes, and headphones. Music instruments or materials used were percussion (20%), and keyboard/piano (17.5%). A small number of music instruments or materials were woodwind (2.5%).

The session in the experimental procedure was offered mostly for one time only (26.3%), followed by 15 times (15.8%), and 12 times (10.5%). However, three research studies did not identify the number of sessions (15.8%). In one case, the sessions were run for thirty minutes (36.8%) followed by sixty minutes (10.5%). There were five research studies that did not indicate the duration of each session (26.3%). Most experimental procedures were conducted one time only, and three times per week equally (21.1%). Six research studies did not identify frequency of sessions (31.6%). Detail of Characteristics of Music Intervention is presented in table 2.

Table 2 Detail of Characteristics of Music Intervention

Characteristics of Music Intervention	Result	*f*	%
1. Intervention theory/ Principles	Neurological music therapy	8	42.1
2. Intervention strategies/Music activities	Music movement	10	52.6
3. Music selection processes	Selected by researcher based on assessment	8	42.1
4. Music delivery methods	Live music	9	47.4
	Recorded music	9	47.4
5. Music instruments/materials	Audio equipment	10	25
6. Number of sessions	One time	5	26.3

Discussion

The discussion presents three main interesting issues including year of publication, intervention theory, intervention strategy, and music delivery method.

Year of publication. The result from this synthesis reported that most research studies were conducted during the period 2011 – 2015 (52.6%) which was the period of establishing a professional organization of neurologic music therapy. Neurologic Music Therapy established a professional organization in 2002 and provided a training program and research (Clair, Pasiali, & LaGasse, 2008). Therefore, there were many research studies used the music techniques of neurologic music therapy as music intervention that published in this period. Examples are the studies of Kwak, in 2007; Kim, et al in 2011; Kim, et al in 2012; Varsamis, et al in 2012; and Jiang in 2013 used the Rhythmic Auditory Stimulation technique (RAS), the study of Chong, et al in 2013 used the Therapeutic Instrument Music Performance (TIMP) technique, and the study of Peng, et al in 2011 used the Patterned Sensory Enhancement (PSE) music technique. *Intervention theory*. The Neurologic Music Therapy or NMT was the most popular intervention theory or principle for developing music intervention of people with cerebral palsy. NMT shares common

ground with the theory of treatment for people with cerebral palsy such as neurological approaches, and neuro-developmental therapy (NDT). Both of these theories are frequently used by other professionals including physical therapists, and occupational therapists (Fetters, 1991; Preuksananon, 2010). NMT is a research-based system of standardized clinical techniques, which provide a structure for the music therapy clinic. The structure is based on scientific knowledge about physiology, neurology, and psychology. The research of NMT indicated the effective applications in neurodevelopmental therapy including people with cerebral palsy, and also reported the effective interventions in the other areas such as neurologic rehabilitation, neuropediatric therapy, and neurogeriatric therapy. The NMT was developed by Dr. Michael Thaut and his colleagues at the Center for Biomedical Research in Music, Colorado State University (Clair, Pasiali, & LaGasse, 2008).

Intervention strategy. In the aspect of intervention strategy or music activity, the result of the synthesis indicated that music movement occurred with the highest frequency. This result correlated with the previous research evidence in the field of using music movement. For instance, the study of Jun et al (2012), reported that music movement therapy increased both physical and psychological states of stroke patients, and the study of Humburg and Clair (2003) indicated that movement with music enhanced gait speed in healthy older adults. In children, music movement led to increasing locomotor skill, and motor performance in jumping and dynamic balance in preschool children (Derri et al., 2001; Zachopoulou et al., 2004). Therefore, in order to improve physical development as the main goal of treatment, music movement was required to be used as the intervention strategy.

Music delivery method. The finding showed that music delivery methods were in the form of live music or recorded music. However, many previous studies demonstrated more positive effects of using live music. For example, Segall (2007) indicated that live music had significantly more effect than recorded music on both physiological and behavioral states in end-of-life patients. This study suggested that live music had vital implications for being the role music therapy in hospice programs, and for using as the nonverbal

communication in evaluating the responds of patients. Bailey (1983) compared the effect between live music and tape-recorded music in hospitalized cancer patients. The result revealed that patients exposed to live music showed significantly less tension anxiety and more vigor than with tape-recorded music. Walworth (2010) compared the effect between using live music and recorded music undergoing Magnetic Resonance Imaging (MRI), reporting that live music had significantly better perception than recorded music.

As seen in research mentioned above, using live music was more beneficial than using recorded music, which contradicted the result of this synthesis. The result of this synthesis identified that either live music or recorded music was able to be applied in clinics for people with cerebral palsy. Additionally, the research mentioned above studied and compared the effect of using live music or recorded music with clients in palliative care. The results of these studies are not entirely relevant for people with cerebral palsy. Therefore, the music delivery method for people with cerebral palsy should be either live music or recorded music.

Recommendation

In terms of recommendation, this part provides suggestions for conducting future research in the field of using music for people with cerebral palsy, and suggests the implications for music therapists or clinicians who work with cerebral palsy to apply in their clinic.

Conducting future research.

The result of this systematic review showed that there were only a few research studies in the field of using music intervention for people with cerebral palsy. Therefore, it is valuable to continue and encourage the researcher who is interested in this field to conduct future research. The recommendation is to conduct both experimental and non-experimental research.

To conduct experimental research, the recommendation is to use the randomized control-group pretest-posttest design, the single-case design, and the case study design in order to investigate deeper information. In terms of participants in the study, the number of participants should be more than ten people for the

randomized control-group pretest-posttest designs and should be one to ten for the single case and case study design. Participants should include other types of cerebral palsy such as athetoid, ataxic, and hypotonia cerebral palsy, because these types were rarely selected for participation in experimental research. Although reserch on spastic cerebral palsy is the most commonly conducted, this focus still needs to be continued in future reserch. The recommendation for the age of participants is to include participants from infancy to late childhood (0 – 12 years old) and early adulthood to middle age (19 – 60 years old) which showed the lack of study in this systematic review. Additionally, future experimental research should investigate the effectiveness of music intervention on other independent variables consisting of emotion, communication, social skills, and cognition.

There commandations for nonexperimental research is to do both qualitative research and quatitative research. The example for qualitative research is historical research which leads to understanding the development of music intervention for cerebral palsy. It is quantitative research to survey research in order to investigate music intervention from music therapists or clinicians who work with cerebral palsy.

Implications for clinics

With regard to the music therapy clinic, the results of this systematic review demonstrated that music interventions were applicable to people with cerebral palsy. The goals of using music interventions covered to physical development, emotion, communication, social skills, and cognition. Music interventions were prepared differently according to the goal.

To improve physical development, music interventions are created by using Neurologic Music Therapy as intervention theory, and Electromyographic (EMG) Biofeedback. Music movement, playing instruments, and music listening are music activities for increasing motor skills. Music should be selected by music therapists based on assessment and could be in the form of live or recorded music. Music instruments are both audio equipment and percussion. For this purpose, music should be used for at least thirty minutes, and three times per week (Yu et al, 2009; Kima et al, 2011; Kim et al, 2012; Varsamis et al, 2012; Kwak, 2007; Chong et al, 2013; Peng

et al, 2011; Wolfe, 1980; Jiang, 2013; Krakouer et al, 2001; Tindal, 2011; Johansson et al, 2014; Scartelli, 1982).

For reducing anxiety as to the emotional outcome, the intervention theory is Procedural Support. Music intervention for this purpose is provided by listening to recorded music which is selected from a limited set. The session was run for at least thirty minutes, for one time (Francis, 2011; Yu, et al, 2009).

The intervention theory for promoting communication is improvisational techniques. Music strategies are playing instruments and singing. Live music is required for the music delivery method. A variety of music instruments can be used such as percussion, piano, and guitar. The music interventions should serve at least thirty minutes, and two times per week (Kho, 2011; Perry, 2003).

In order to promote social skills, music interventions are based on improvisational techniques. Music activities are playing music instruments and music listening. Music is presented in the form of live and recorded music. The music therapy session should be scheduled for thirty minutes, and two times per week (Francis, 2011; Kho, 2011; Ahonen-Eerikäinen et al, 2008).

The last goal of treatment is cognition. Listening to recorded music is used to improve attention, and to have an effect on parasympathetic activity. The duration for listening to music is fifty minutes. The song for listening should be selected by the researcher (Francis, 2011; Orita et al, 2012).

Details of music intervention guidelines for people with cerebral palsy is presented in table 3.

Table 3 Music intervention guidelines for people with cerebral palsy

Goal	Intervention theory	Music Activity	Music selection	Music delivery	Instrument	Duration (minutes)	Frequency
Physical development	●Neurological music therapy ●Electromyographic (EMG) Biofeedback	●Music Movement ●Playing instrument ●Music listening	●Selected by researcher based on assessment	●Live and Recorded music	●Audio equipment ●Percussion	●At least 30	●3 time per week
Emotion	●Procedural support	●Music listening	●Participant selected from limited set	●Recorded music	●Audio equipment	●At least 30	●1 time only
Communication	●Improvisation technique	●Playing instrument ●Singing	●Pre-selected by researcher	●Live music	●Percussion ●Guitar ●Piano	●At least 30	●2 times per week
Social skills	● Improvisation technique	● Playing instrument ● Music listening	● Pre-selected by researcher	● Live and Recorded music	● Percussion ● Guitar ● Piano ● Audio equipment	● At least 30	● 2 times per week
Cognition	N/A	● Music listening	● Pre-selected by researcher	● Recorded music	● Audio equipment	● 50	● 1 time

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