
研究レポート

Trends and issues in music therapy intervention research in neonatal intensive care units

NICUにおける音楽療法に関する介入研究の動向

Oyama Y · Taniguchi M · Tanaka M · Kuroiwa M · Shimizu M · Miyamoto Y

Abstract:

[Aim] This literature review of music therapy (MT) in Neonatal Intensive Care Units (NICU) provide an overview of the national and international literature, identify trends in intervention research over the past decade, and identify future issues. [Methods] We conducted a literature search using databases contracted by affiliated institutions. We found 145 search results from PubMed, 19 from ICHUSHI-Web, and 8 from CiNii, However, we excluded the Cinii results because they were all duplicates. [Results] From 164 references, excluding conference proceedings and literature reviews, we screened the texts and abstracts; 15 references were included if they were intervention studies of MT in the NICUs and met US PRISM evidence level criteria I-2 and I-3. [Conclusion] Intervention studies in the last decade have reported effects of MT on both mothers and infants. In addition, MT tended to have physiological and psychological effects. Future work is needed to further clarify the uniformity (rather than diversity) of evaluation measures and the differences in effects between MT delivery methods.

Keyword: Music therapy, Neonatal Intensive Care Unit (NICU), Clinical trial, Intervention research, Literature review

I. Background

Premature and low-birth-weight infants receive intensive care and management in the neonatal intensive care unit (NICU). Fetal growth and development normally occur “in utero” in an appropriate environment. However, premature infants expend more energy than they would in the stable environment of the womb (Standley, 2003. Darcy, 2012). Additionally, the NICU environment subjects infants to physical and psychological stress from the sounds of ventilators, life-support systems, and other mechanical noises, leading to problems such

as unstable breathing and poor weight gain (Hennessey, 2006).

By contrast, environmental stimulation in the form of sound has a positive effect on the physiological stability of the infant (Namjoo, 2021; Alay, 2019). The fetus can perceive sounds after 20 weeks of gestation. Particularly, as the rhythm of the mother's heartbeat, pulse sounds, and speech heard in utero become synchronized, and the central nervous system develops the ability to discriminate sounds and establishes a system to detect beats and periodicity (Zentner, 1998; Winkler, 2009). Listening to the mother

voice or sounds and music of similar frequency helps stop the infant from crying, and has positive effects on predecreased apnea due to increased oxygen levels, improved comfort in the brain, stable vital signs, and enhanced suckling ability or weight gain (Bagli, 2023). In addition, it has been reported that the approach to mothers is also indirectly linked to effects on the infant, as the mental stability of the mother leads to the physiological and psychological stability of the infant (Kobus, 2022).

Music therapy (MT) is a complementary and alternative medicine not widely practiced in Japan. The number of music therapists in Japan and their medical knowledge is still insufficient. As a result, there is little evidence of the effectiveness of music therapy. Against this background, people are cautious about introducing music therapy. Therefore, music therapy in Japan is limited to psychological support as part of palliative care (Kuhl, 2002; Suzuki, 2019; Włodarczyk, 2007). Conversely, MT is practiced as a form of medical care in Europe, the United States, and other European countries, and its effective clinical outcomes for preterm and low-birth-weight infants have been recognized. MT in the NICU is one trend in medical intervention.

II. Objectives

This study reviews the domestic and foreign literature on MT in the NICU to identify trends over the past decade in terms of intervention research and effectiveness, and future challenges.

III. Methods.

We searched databases subscribed to by the authors institutions. We searched both domestic and foreign literature related to the NICU and MT. We used PubMed for English-language life science literature from outside Japan and the Web

version of the Central Journal of Medical Science (ICHUSHI-Web) and CiNii from the National Institute of Informatics for domestic literature searches, focusing on articles published within the last 10 years. The articles were researched on 3 October 2024. They cover the last 10 years from 2013-2024. Music therapy in NICUs was limited to intervention studies. They were screened for similarity in terms of intervention targets and effectiveness. The search terms were “music therapy” and “NICU” (in both English and Japanese). MT intervention studies in the NICU were selected from the retrieved literature. We excluded reviews, fact-finding studies, literature reviews, scale development studies, and duplicate literature. For intervention studies, we focused on randomized controlled trials (RCTs) using the US PRISM standard of evidence (Fig 1). Ethical considerations were also considered.

IV. Results

This study was a literature review. We found 145 hits in PubMed, 19 in ICHUSHI-Web, and 8 in CiNii. However, we excluded the 8 articles in CiNii because they were all duplicates of articles found in the medical journals. We screened 164 literature for text and abstracts, excluding conference proceedings and literature reviews (Fig 2). Table 1 shows the included 15 literature on MT intervention studies in the NICU that were available in full text and met the US PRISM evidence level (I-2, I-3).

1. Overview of MT intervention subjects

Figure 3 shows an overview of the MT intervention studies. The target group receiving MT was labeled RTT (Receiving Therapy Target), and the target group benefiting from MT was labeled ETT (Effecting Treatment Target). RTT and ETT were divided into three categories:

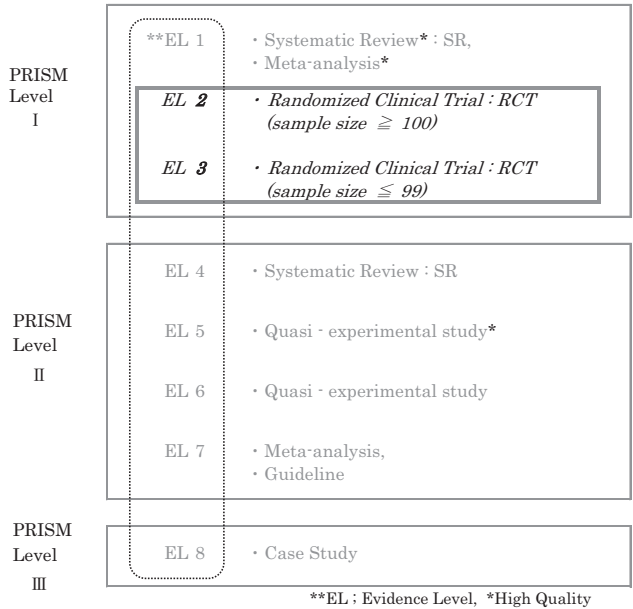


Fig 1 Classification of articles for analysis (PRISM Evidence Level)

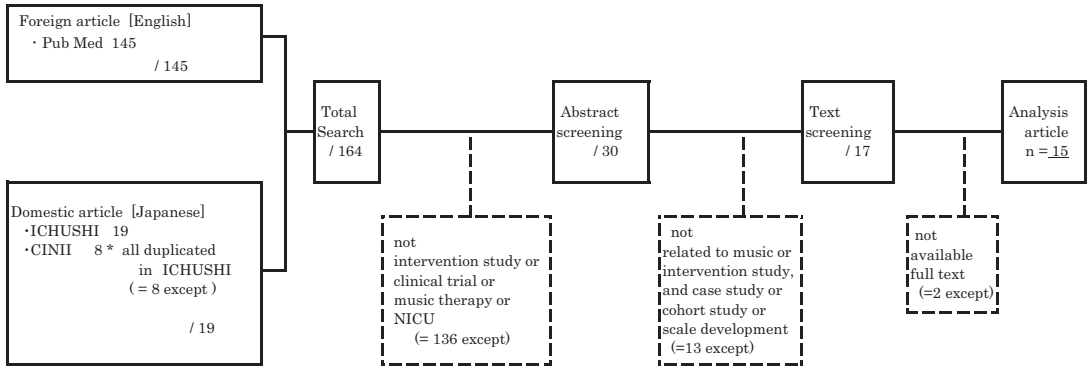


Fig 2 Flowchart of Literature Search

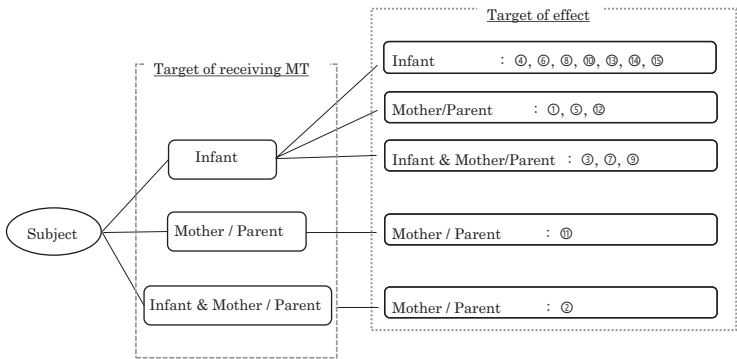


Fig 3 Overview of Participants by MT intervention

Table 1 Overview of Intervention Studies on Music Therapy in the NICU

No	Source	Participant n GA	Objective	Design [PRISM]	Type, method, duration of intervention	Measurements	Results
①	Kobus et al. 2022. Envir Res Pub Heal, Germany	Mothers: n=33 32w GA >	MT to infant, Prevalence assessment of maternal distress and well-being	RCT [1 - 3]	・ 2 times/week (2 week of life ~DC) ・ during mother-infant contact ・ therapist Singing ・ playing instrument	Mothers: ・ CES-D scale, ・ IES-R scores	・ Decrease in maternal depressive symptoms ・ Decrease in perceived distress due to preterm birth ・ Decrease in IES-R subscale
②	Kehl et al. 2019. BMJ, Switzerland	Parent couples : n=16 32w GA >	MT to infant & parent, Assessment of parents' anxiety/ stress/ depression relief & support for the process with their infant	RCT, Pilot study [1 - 3]	・ 2-3 times/week, 20 min (AM after feeding) ・ during parent-infant contact ・ mother's singing	Parent couples: ・ Psychological Questionnaires (measuring scale anxiety/depressive) ・ Stress Questionnaire	・ Parents' anxiety, reduction ・ Reduction of mother's depression ・ Reduction of mother's stress symptoms
③	Ghetti et al. 2023. JAMA New, Argentina/Columbia/ Israel/ Norway/ Poland	Parent & Infant pair: n=213 35w GA >	Mothers MT to infant, Psychoclinical impact on the parent or infant	RCT [1 - 2]	・ 3 days/week, 7 times ・ hospitalization, 6 mon after DC ・ parents singing to their infants	Parents/Mothers: ・ PBQ, EPDS, GAD-7, ・ Parental Stress Scale, Infants: ・ ASQ	・ No significant
④	Bauer et al. 2023. Pediatr Gastro Nutr Argentina/Columbia Israel/ Norway/ Poland	Infants: n=201 35w GA >	Mothers MT to infant, Assessment related to weight gain	RCT [1 - 2]	・ 2-3 times/week, 30 min ・ MT on infant at feeding time ・ parents singing to their infant	Infants: ・ Infants Weight, (at birth/enrollment/discharge) ・ Weight Percentiles Z - scores, ・ Weight Gain Velocity, EUGR	・ No significant
⑤	Gaden et al. 2022. Pediatrics, Argentina/Columbia/ Israel/ Norway/Poland	Parent & Infant pair: n=213 35w GA >	Mothers MT to infant, Evaluate short-term effects of abstraction on mother-infant bonding, parental anxiety, and maternal depression.	RCT [1 - 2]	・ 3 times/week, ・ parent-lead singing	Parents/Mothers: ・ PBQ, GAD-7, EPDS	・ No significant
⑥	Shokri et al. 2023. Eur Pediatr, Germany	Infants: n=52 26-30w GA	MT & PIOMI to infant, Clinical effect on infants feeding progression	RCT [1 - 3]	・ 1 time/day, for 10 days, 10 min, ・ consisted of 5 min of PIOMI ・ selected Mozart composition , ・ speaker placed inside incubator	Infants: ・ POFRAS, ・ Weight Gain, Milk Volume ・ Feeding Progression ・ Length of Hospitalization.	・ Decreasing days to discharge ・ Feeding progression
⑦	Ranger et al. 2018. Compl Ther Med, Germany	Infants: n=21 > 26w GA	MT to infant, Effects on preterm infants and their mothers	RCT [1 - 2]	・ 15 minutes ・ live herbal performance ・ by therapists	Mothers: ・ STAI-X1.30 german version Infants: ・ HR, HRV, RR, Spo2, ・ Perfusion Index, ・ Pulse Transit-Time	・ Increase indicative of parasympathetic tone in infants
⑧	Alay et al. 2019. Pak Med Assoc, Turkey	Infants: n=45 no data	MT to infant, Effect on physiological measurements, hospital stay & stress symptoms in fants	RCT [1 - 3]	・ 30 minutes, 65db ・ classical music or lullabies ・ during daily nursing care ・ by speaker	Infants: ・ HR, RR, T, BP, Spo2, ・ gestation period ・ Length of Hospitalization ・ stress symptoms list (4 stage)	・ Infants' body temperature is affected ・ Influence on Spo2 ・ Decreased stress in infant ・ Decreased length of hospital stay
⑨	Epstein et al. 2021. Eur Pediatr, Israel	Mother & Infant pair: brain- disorder n=35 32w GA <	Mothers MT to infant, Evaluation of physiological responses in mothers & infants with severe brain	RCT [1 - 3]	・ 2-3 times/week, ・ 30 min after feeding ・ maternal singing	Mothers: ・ STAI, ・ HR, HRV, LF/HF, RR, Spo2 Infants: ・ HR, HRV, LF/HF, Spo2, RR, ・ APIB	・ Induction of physiological instability in infant ・ Behavioral instability in the infant ・ Induction of maternal anxiety
⑩	Barandouzi et al. 2020. Compl Ther Med, Iran	Infants: 120 32-35w	MT & sucrose to infant, Comparative study of analgesic effects on venipuncture's pain in infants	RCT double -blind [1 - 2]	・ 10 min/ 2 min before venipuncture ・ headphone before venipuncture	Infants: ・ HR, RR, Spo2, ・ PIPP	・ Pain relief for 30 seconds after puncture ・ No pain relief during puncture
⑪	Variaglu et al. 2020. Breastfe Med, Turkey	Mothers: n=40 28-34w	MT to mothers, Effect of breast milk production	RCT [1 - 3]	・ 15 min, 2 times/day (11, 16) ・ 2-4 days, milking training begins ・ play music while breastfeeding	Mothers: ・ STAI ・ Cortisol tests (saliva) ・ Amount of breast milk	・ Reduce mother's stress ・ Support breast milk production
⑫	Deroddy et al. 2024. Matern Fetal Neon, USA	Mothers: n=40 26-30w	Mothers MT to infant, Effects on maternal mental health	RCT [1 - 3]	・ 2 times/day, ・ recorded mother's voice.	Mothers: ・ DASS-21	・ No significant
⑬	caparros et al. 2018. Adv Neonatal Care, Spain	Infants: 17 32-36w	MT to infants, physiological effects on the infants	RCT [1 - 3]	・ 3 times/day×3 days, for 20 min ・ MT made with artificial intelligence	Infants: ・ HR, RR, BP	・ Reduction of infant stress effects
⑭	Tekgunduz et al. 2019. Pain Manag Nurs, Turkey	Infants: n=106 26-36w	MT & oral glucose to infants, provide pain relief during removal and reinsertion of a tracheal tube and nasopharyngeal aspiration	RCT [1 - 2]	・ afternoon, 40-50db ・ play CD of lullabies	Infants: ・ NIPS ・ PIPP	・ Significant pain reduction in infant
⑮	Mitsutake et al. 2017. Jap Acad Neon Nurs, Japan	Infants: n=10 28w ≥	MT to infants, assessing their physical activity levels & sleep quality	RCT [1 - 3]	・ 2 times/day, for 1 hour ・ play classical and music box CDs	Infants: ・ HR, RR, Spo2, ・ Physical activity & sleep/Actigraph	・ Decrease in morning physical activity ・ Increase in morning and evening non-REM sleep

APIB: Assessment of Preterm Infants' Behavior, ASQ: Ages and Stages Questionnaire, CA: corrected age, CES-D: Center for Epidemiologic Studies Depression Scale, CG: control group, DASS: Depression Anxiety Stress Scales, GAD-7: Generalized Anxiety Disorder-7, IES-R: Impact of Event Scale-Revised, LME: linear mixed-effects models, EPDS: Edinburgh Postnatal Depression Scale, MPAS: Maternal Fetal Attachment Scale, MT: Music therapy, NIDCAP: Neonatal Individualized Developmental Care and Assessment Program, NIPS: Neonatal Infant Pain Scale, NISS: Neonatal Infant Stressor Scale, PBQ: Postpartum Bonding Questionnaire, PIPP: Premature Infant Pain Profile, PIOMI: premature infant oral motor intervention, POFRAS: Preterm Oral Feeding Readiness Scale, PSS: Parental Stress Scale, PVL: periventricular leukomalacia, RCT: Randomized Controlled Trial, SSC: Soft structure Carrier, STAI: State-Trait Anxiety Inventory.

Table 2 Music Intervention Evaluation

Target	Evaluation	n*	Outcome measure	Paper No.
Infant	Physiological	5	HR, HRV, RR, Spo2, BP, Perfusion Index, Pulse-Transit-Time	⑦, ⑧, ⑨, ⑩, ⑪
	behavioral / sleep	2	Feeding Progression, Physical activity, sleepActigraph	⑨, ⑪
	psychological stress	2	Stress list	⑧, ⑩
	growth	2	Wt, wt %, wt gain velocity, EUGR, POFRAS, milk volume,	④, ⑤
	Length of hospitalization	2	Length of Hospitalization	⑥, ⑧
	pain	2	PIPP, NIPS	⑩, ⑫
	development	1	ASQ	③
Mother / Parent	psychological stress	8	CES-D, IES-R, EPDS, GAD-7, PSS, EPDS, STAI, HR, Spo2, HRV, LF/HF, Cortisol, DASS-21	①, ②, ③, ④, ⑦, ⑨, ⑩, ⑫
	breast milk production	1	Amount of breast milk	⑩
	mother-infant bond	1	PBQ	⑤

* One study has multiple interventions, n number not matched

Table 3 Music therapy delivery method and effectiveness

Type of intervention			n=15*	paper No.	result**
Live	Singing	by maternal voice	5	②, ③, ④, ⑤, ⑨	P, NS, N
		by therapist	1	①	P
	Instrument music	by therapists	2	①, ⑦	P
Recorded	Song	recorded maternal voice	1	⑫	NS
	Music	recorded lullaby	2	⑧, ⑭	P
		classical music CDs	3	⑥, ⑧, ⑮	P
		music boxes	1	⑮	P
		playing music CDs	3	⑩, ⑪, ⑬	P

* One study has multiple interventions, n number not matched

** P: positive correlation, N: negative correlation, NS: not significant difference

“infant only” in the NICU, “mother or parent only” with an infant in the NICU, and “both infant and mother or parent. We classified 13 RTT cases as ‘infant only’ 1 as ‘mother/parent’ and 1 as “infant and mother/parent.” In the 13 RTT literature, 7 were classified as “infant only,” 3 as “mother/parent only,” and 3 as “infant and mother/parent.” One RTT and one ETT literature were classified as “mother/parent.” No effect was found on “infant” or “mother/parent” .

2. Evaluation by MT intervention

Table 2 shows the content of the ETT evaluations and their indicators. Seven and three ETT evaluations were categorized for the “infant” and “mother/parent, respectively. The infant was further evaluated by five physiological measures. The physiological measures included heart rate (HR), heart rate variability (HRV), respiratory rate (RR), saturation of pulse oximetry Oxygen (Spo2), blood pressure (BP), perfusion index, pulse-pulse perfusion index, and pulse-transit-time. Two studies assessed activity and sleep, including feeding progression, physical activity, and sleep actigraph. For infant stress, the stress list was used as an indicator in studies. Additionally, some studies assessed additional physiological indicators. Two studies used growth assessment, length of hospital stay, and effect on pain. Growth and length of stay were sometimes used together. One study assessed infant development using the Ages and Stages Questionnaire (ASQ) as the instrument.

The ETT assessment of “mother/parent” was divided into three categories: psychological distress, breastfeeding, and mother infant bonding. Particularly, the most common assessment of “mother/parent” was psychological distress (eight literatures). The following indicators were also used: Center for Epidemiologic Studies

Depression Scale (CES-D), Impact of Event Scale-Revised (IES-R), Edinburgh Postnatal Depression Scale (EPDS), Generalised Anxiety Disorder -7 (GAD-7), Parental Stress Scale (PSS), Edinburgh Postnatal Depression Scale (EPDS), State-Trait Anxiety Inventory (STAI), HR, Spo2, HRV, Low Frequency/Hi Frequency (LF/HF), cortisol, and Depression Anxiety Stress Scales-21 (DASS-21). Maternal stress and mother infant bonding were outcome measures used in several literature.

3. Method and effect of MT delivery to the target population

Table 3 shows the MT delivery methods and their effects. Two types of MT delivery were used: live and recorded music. Live music was used in seven literature, which consisted of singing by the mother and therapist and instrumental music played by the therapist. Therapist singing and instrumental music reduced the emotional distress of the mothers. Singing by the mothers had a positive effect in one case (reduced mental stress for mothers and parents), a negative effect in the other case (increased parasympathetic tone in the infants), and three references had no significant results.

The recorded MTs included one case of singing and seven cases of instrumental music. Recorded maternal singing showed no significant effect. For recorded music, there were three literature for classical music, two for lullabies and other music, and one for music boxes. MT with recorded music reduced psychological distress in both the infant and mother. In addition, positive effects were found for the infant in all seven literature for the infant, including pain relief, increased non-REM sleep, stable morning activity, increased feeding, shorter hospital stay, and physiological stability.

4. Countries surveyed and number of participants

We found eight single-country surveys. Of these, Germany and Turkey had three literatures, and Switzerland, Israel, Iran, the USA, Spain and Japan had one each. Israel also had three joint surveys and one literature. One multinational joint survey had three literature in 2018-2022, involving five countries Argentina, Colombia, Israel, Norway, and Poland. The majority of the literature was from Europe.

The participants were categorized into three groups: < 99, between 100 and 199, and >200. Ten literature were found for 99 participants, two for between 100 and 199 participants, and three >200 participant.

V. Discussion

This study aimed to identify trends and issues in intervention research on MT in the NICUs. Particularly, it considers the research trend over the last decade compared with the findings of an integrative review of MT for infants and parents in the NICU in 2012 (Friederike, 2012).

1. Subject of the MT intervention

Most intervention studies tended to have a music approach for the infant, as 13 of the 15 RTTs were “infant only”. The majority of studies were quantitative and focused on the short-term effects on preterm infants. Meanwhile, MT for preterm infants has been seen as overstimulation. In light of concerns about potential dangers, the present review has widened the scope of the study beyond “the infant”. Only one study each was found for, “mother/parent only” and “infant and mother/parent” receiving the music approach, indicating a broadening of the scope of the study. Standley (2012) found that MT wires the brain of preterm infants and promotes typical development similar to that of full-term

infants. The mental and parenting stability of the mother has a significant impact on the growth and development of the infant (Bowlby, 1969. Bruner, 1976). The target population for MT is broadened because the approach to mothers is also expected to have an indirect effect on the infant. In addition, ETT showed different characteristics when further classified by RTT. Most of the literature on ETT by RTT to “infants” was limited to “infants”. No literature was found on ETT to “mothers/parents” or “infants and mothers/parents” where the RTT was to “infants”. Due to the small number of subjects, the effects of the “mother/parent” or “infant and mother/parent” approach on the “infant” were unclear.

The only target group wherein MT showed the greatest number of effects was “infants”, with positive effects particularly on “infant’s physiological indicators”; MT had a positive effect on physiological indicators such as HR, HRV and Spo2, and some effects were also found on stress, growth, length of hospital stay and pain. Particularly, studies of the effects of MT on “infants” in NICU suggest a high benefit in improving physiological responses and reducing the length of stay. Findings showing that physiological indicators, such as HR and Spo2 were improved by MT indicate that MT likely contributes to stress reduction and stabilization (Czarnecki, 2020). MT may also contribute to shorter hospital stays, an important outcome, particularly in settings with limited NICU resources (Standley, 2003).

Because only a few studies were found for MT with mothers only, with limited effects, that the importance of mothers' own stress and emotional support is recognized, the effects of MT may be weaker than its direct effect on the “infant”, although more in-depth research is needed in this regard.

2. Evaluation of the MT intervention

Although Frienderike (2021) has reported on previous MT intervention studies using physiological assessment and analgesic effects as indicators and evaluations in previous MT intervention studies, the evaluation measures are very different from our study result. Although HR and Spo2 are used in the physiological evaluation of the infant, the evaluation of the mother/parent focuses on the measurement of psychological distress, a feature that highlights the challenges in assessing the effectiveness of MT. For example, different measures of maternal distress are used (CED-D, IES-R, and EPDS), which may lead to different results. This is one of the reasons for the variability in the study results. With regard to stress reduction, future research should pay more attention to how the MT effect affects “maternal physiological indicators (HR and HRV)”. Investigating the relationship between maternal psychological and physiological distress is important for the practical application of MT (Standley & Walworth, 2010), and future research should investigate how the MT effects of stress reduction affect “maternal physiological indicators (HR and HRV)” in more detail.

3. Methods and effects of MT delivery to the target

Evaluations of live and recorded performances show no differences in terms of emotional cognition; however, the impact on one's emotions is greater for live performances, and significant differences were found in active enjoyment depending on the music tempo (Nakamura, 2014). The effects on growth and development, including long-term prognosis, of preterm and underweight infants are related to postnatal energy expenditure and accumulated protein deficiencies (De Curtis, 2004; Embelton, 2001). Ideally, the environment should be similar to the intrauterine environment

to minimized stress on underdeveloped organs and immature functions.

This study used both live delivery and recorded music, each with different effects. The live delivery consisted of vocal and instrumental music from the therapist and mother, whereas recorded music consisted of classical music, lullabies and music boxes. The positive effects of live music were mostly found in the literature, indicating that vocal and instrumental music from therapists and mothers may provide emotional stability for infants and mothers. This suggests that “human connection” plays an important role in MT (Gold, 2006). Recorded music also has a positive effect in all seven literature. The effects of classical music and lullabies were particularly strong. The studies tended to show that the music type affects an infant's physiological and psychological stability. Recorded music is easily used, allows for continuous intervention, and opens up the possibility of its widespread use in future MT practice in NICUs (Nilsson, 2009).

4. Surveyed countries and number of participants

Many MT studies have been conducted in the USA and European countries (e.g Germany, Turkey and Switzerland). Germany has included MT as a nonpharmacological therapy in its health insurance system. Therapy is available at a low cost from state-licensed therapists. Therapists are also well-paid and have stable employment opportunities. MT qualifications are set by the Certification Board for Music Therapists on a state-by-state basis. It can be studied at universities accredited by the American Music Therapy Association, and hospitals and rehabilitation facilities have a well-developed working environment. In the USA, MT has been used for longer than in Germany to treat the psychosomatic problems of soldiers during

the war (Sullivan, 2007; Ichie, 2006). It is the birthplace of modern MT. It is generally a state rather than a national qualification system.

The USA has an appropriate working environment, with many music therapists working in hospitals and rehabilitation facilities, and research resources for MT were abundant.

The number of participants was also not limited to studies where a small number of studies were the majority. There is a trend toward more reliable data collection through large RCTs.

VI. Conclusions

Intervention studies in the last decade have tended to suggest that MT affects “infants”', In addition, much of the literature has reported that MT has physiological and psychological effects on infants and their mothers. MT in the NICU affected not only the infant but also the mother. Direct effects on the mothers also led to indirect effects on the infant; it was suggested that MT had an MT effect on the infant and its parents' therapy. Future issues include further clarification of the “generalizability (not limitation) of effects on mothers/parents” , “standardisation (not diversity) of evaluation measures” , “differences in effects between MT delivery methods” , and “specific mechanisms of MT” . We hope that MT interventions for NICU infants will be expanded in Japan in the future.

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