Music therapy improves social interaction and verbal communication skill among children with autism spectrum disorder: A systematic review and meta-analysis

Shakira Amiraḥ1, Muhammad F. Abdurrahman1, Raihan F. A. Akbar1 and Intan C. Mulya2

1Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia; 2Department of Obstetrics and Gynaecology, Monash University, Melbourne, Australia.

*Corresponding author: imul0004@student.monash.edu

Abstract

The incidence of Autism Spectrum Disorder (ASD) is constantly increasing, in which 6 of 1000 ASD children are from Asia. Music therapy as a developing alternative is believed to improve communication and expression skills in children with ASD. Unfortunately, no specific meta-analysis has evaluated social interaction and verbal communication skills in children with ASD. Therefore, the aim of this meta-analysis was to evaluate music therapy in children with ASD. We performed a comprehensive literature review on PubMed, Scopus, Embase, Wiley, and Proquest to study the efficacy of music therapy as an ASD management therapy until October 20th, 2022. Twenty-three randomized controlled trials involving patients with ASD, where 1129 patients were assigned in the intervention group and 759 patients in the control group, were included in qualitative and quantitative analysis. The pooled estimates revealed that music therapy increased the social interaction score with mean difference (MD) = 2.08 (95% confidence interval [CI]: 0.35–3.81; p < 0.02), social interaction score based on Autism Diagnostic Observation Schedule with MD: 0.77 (95% CI: 0.03–1.51; p < 0.04), verbal communication skill based on Autism Diagnostic Interview-Revised with MD = 0.90 (95% CI: 0.79–1.00, p < 0.01). In conclusion, music therapy has excellent efficacy and strong potency as a part of ASD management. Nevertheless, more clinical trials with similar parameters are still required to confirm these findings.

Keywords: Autism spectrum disorder, developmental disorder, music therapy, social interaction, verbal communication skill

Introduction

The prevalence of Autism Spectrum Disorder (ASD) keeps on increasing over the years. Among school-aged children, it is estimated that the ratio of children with ASD is 6 out of 1000 in Europe, 7 out of 1000 in North America, and 6 out of 1000 in Asia [1]. ASD is a developmental disorder caused by brain disruption, characterized by abnormal growth and atypical connectivity of the brain [2]. In children with ASD, the most frequently identified characteristics are verbal and non-verbal communication difficulties, struggle to fit into society, lack of activity motivation, and repetitive behaviors [3].

Several therapies to minimize clinical manifestations of ASD were developed in 1997, in response to the escalation of the cases [4]. The therapies include pharmacological therapy,
behavioral therapy, speech therapy, linguistic therapy, sensory integration therapy, and music therapy [5,6]. In the wake of technology development, robot has even been used to improve social engagement among ASD children [7]. Regardless, music therapy (MT) is frequently employed in ASD management [6]. In its early introduction, around 1940s, MT was uncommon, until 1997 where the United States (US) experienced the exponential growth of ASD cases [8]. Nonetheless, the evidence of music utilization in improving social and behavioral ability in ASD still requires further study. The most recent meta-analysis on this topic was published in 2014, resulting in the need for an updated review to review therapy potential based on the latest studies [9]. Therefore, this meta-analysis aimed to evaluate music therapy’s effectiveness in improving social interaction and verbal cognitive skills.

**Methods**

**Literature search strategy**
A comprehensive literature search was performed on PubMed, Scopus, Embase, Wiley, and Proquest to evaluate the studies reporting music therapy efficacy for Autism Spectrum Disorder (ASD) until October 20th, 2022. The search was performed using the following keywords combination: (“Cognitive Behavioral Music Therapy” OR “Music therapy” OR “musical therapy”) AND (“Autism” OR “autistic disorder” OR “Asperger disorder” OR “Pervasive Developmental Disorder”).

**Study eligibility criteria**
In terms of eligibility, the study inclusion criteria were: (1) study type, randomized control trials; (2) study population, patients with ASD; (3) intervention, music therapy; (4) study outcome, social interaction, and verbal communication skill; (5) have control groups (standard therapy or non-MT). Meanwhile, the exclusion criteria were: (1) unfinished study during study search interval; (2) inaccessible full-text study; (3) study with languages other than English and Indonesian. Additionally, duplicated studies were screened using Microsoft Office Excel. Screening of the study title and abstract was conducted by three independent authors (S.A., M.F.A., R.F.A.A.). Different findings were resolved by reaching consensus.

**Data extraction**
We extracted the studies in the form of a table to include the following data: (1) authors and year of publication; (2) study characteristics, including study design and location; (3) population of the study, such as intervention and control sample size, genders, age in average; (4) intervention, name, frequency, and content of therapy; (5) study outcome, social interaction, and verbal communication skill.

**Quality study assessment**
The quality of the study was also assessed using Cochrane Revised Risk of Bias (RoB 2.0) for randomized controlled trials. The RoB 2.0 evaluated five domains: randomization bias, bias of intended intervention deviation, missed result data, measurement result, and bias of reported result. In terms of quality, a study was considered good if the study fulfilled reasonable study requirements converted using the Agency for Healthcare Research and Quality (AHRQ) standard (https://effectivehealthcare.ahrq.gov/). The study was evaluated by three independent authors, in which disagreements were discussed by consensus.

**Quantitative study analysis**
Data analysis was performed on Review Manager 5.4 (Cochrane Collaboration, Oxford, UK). The clinical result of dichotomous data was reported as Risk Ratio (RR). A confidence interval (CI) of 95% was measured, where \( p<0.05 \) was considered as statistically significant. Statistical heterogeneity was measured using the \( I^2 \) method (<25% for low heterogeneity, 25–50% for moderate heterogeneity, and >50% for high heterogeneity). If high heterogeneity was identified in a meta-analysis study, additional analysis would be carried out with a DerSimonian—Laird random effects model, as suggested by a previous report [10].

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Results

Study characteristics and outcome
Of 2566 collectively identified records, 16 studies were determined to be eligible for the systematic review. The determination of eligible studies was performed through a series of searching and selection stages which are presented in Figure 1. Sixteen randomized controlled trials with a total of 1129 patients with ASD in intervention and control groups were included in quantitative and qualitative analysis. The studies were conducted in various countries, including Arab, United States (US), Netherlands, Colorado, India, Iran, Canada, Korea, France, Norway, and United Kingdom (UK). The entire study was published from 2012 to 2022 in the last ten years. Patients’ ages varied from 4 to 16 years, distributed in the intervention and control groups.

Our systematic and meta-analysis reviewed studies based on a literature search according to the inclusion and exclusion criteria. We identified 16 studies fulfilling the criteria for the systematic review and 11 studies for meta-analysis [11–26]. The characteristics of the included study are presented in Table 1. The summary of study outcomes is presented in Table 2. The utilized intervention was music therapy with various frequencies. Study outcomes included social interaction and verbal communication skills. The summary of the risk of bias and other applicability concerns is presented in Figure 2. Overall quality of the studies was satisfactory, though there are few studies indicating some concern due to unexplained randomization process and the deviations of intended outcomes.

Meta-analysis of music therapy efficacy on social interaction
A pooled analysis was carried out to evaluate the music therapy potency on ASD compared to the group control. The results of this analysis are presented in Figure 3. The music therapy intervention was shown to significantly improve the social interaction of ASD children (p=0.02) with MD=2.08 (95% CI: 0.35–3.81). High heterogeneity was observed in this analysis with I²=63%. The variation of the used questionnaire type can cause high heterogeneity.

A sub-group analysis was performed for the MT effect on social interaction assessed using Autism Diagnostic Observation Schedule (ADOS). Only a single study reporting the outcome using ADOS with sufficient data [12], hence included in the sub-group analysis. The results are presented in Figure 4. The result showed that music therapy significantly increased ADOS score (p=0.04) with MD=0.77 (95% CI: 0.03–1.51). The heterogeneity of this analysis was I²=53%.

Meta-analysis of music therapy efficacy on verbal communication skill
The efficacy of MT on verbal communication, reported by five studies [12, 14, 18, 24, 25], was evaluated through meta-analysis. The data were derived from a total of 783 patients (302 versus 481 for intervention versus control, respectively). The results of this meta-analysis are presented in Figure 5. MT intervention was revealed to be significantly efficacious in improving the verbal communication as compared to control (p<0.001) with MD = 1.26 (95% CI: 0.57–1.94). The identified heterogeneity within this analysis was high with I²=74%, which might be attributed to different tools used in the studies.

A sub-group analysis was then carried out for results obtained from ADI-R assessment. Two studies with three kinds of intervention were included in this analysis [12, 16]. Pooled estimates of ADI-R score are presented in Figure 6. We found that the efficacy remained significant in this sub-group analysis (p<0.001, MD=0.90 [95% CI: 0.79–1.00]). No heterogeneity was found in this analysis with I²=0%.
Table 1. Characteristics of the included studies

<table>
<thead>
<tr>
<th>Author, Year [Ref.]</th>
<th>Design Study</th>
<th>Study Location</th>
<th>Sample</th>
<th>Treatment</th>
<th>Quantity and Duration</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharda et al., 2018 [11]</td>
<td>RCT</td>
<td>Canada</td>
<td>26</td>
<td>MT</td>
<td>8–12 weeks</td>
<td>Non-music intervention</td>
</tr>
<tr>
<td>Bieleninik et al., 2017 [12]</td>
<td>RCT</td>
<td>Norway</td>
<td>High intensity: 90</td>
<td>Improvisational MT</td>
<td>5 months</td>
<td>SRS, ADOS, ADI-R</td>
</tr>
<tr>
<td>Porter et al., 2016 [13]</td>
<td>RCT</td>
<td>United Kingdom</td>
<td>Low intensity: 92</td>
<td>MT and standard care</td>
<td>12 weekly sessions, lasting 30 min</td>
<td>Standard care</td>
</tr>
<tr>
<td>Rabeyron et al., 2020 [14]</td>
<td>RCT</td>
<td>France</td>
<td>19</td>
<td>MT and standard care</td>
<td>8 months, 25 sessions, lasted 30 minutes of each session</td>
<td>Music listening</td>
</tr>
<tr>
<td>LaGasse et al., 2014 [15]</td>
<td>RCT</td>
<td>Colorado</td>
<td>10</td>
<td>MT</td>
<td>50-min session, twice a week for 5 weeks</td>
<td>Social group</td>
</tr>
<tr>
<td>Crawford et al., 2017 [16]</td>
<td>RCT</td>
<td>United Kingdom</td>
<td>High intensity: 90</td>
<td>Improvisational MT</td>
<td>3 x 60-min sessions/week for 5 months</td>
<td>ADOS, SRS</td>
</tr>
<tr>
<td>El-Tellawi et al., 2022 [17]</td>
<td>RCT</td>
<td>Saudi Arabia</td>
<td>38</td>
<td>Tomatis Sound Therapy</td>
<td>30 h (15 sessions) within three months</td>
<td>No intervention</td>
</tr>
<tr>
<td>Thompson et al., 2013 [18]</td>
<td>RCT</td>
<td>Norway</td>
<td>12</td>
<td>Family-centered MT</td>
<td>Once a week for 16 weeks.</td>
<td>VSEEC, SRS-PS, MBCDI</td>
</tr>
<tr>
<td>Pater et al., 2022 [19]</td>
<td>RCT</td>
<td>Netherland</td>
<td>50</td>
<td>Papageno MT Program</td>
<td>20 music therapy sessions of approximately 40 minutes.</td>
<td>-</td>
</tr>
<tr>
<td>Pedregal et al., 2021 [20]</td>
<td>RCT</td>
<td>United Kingdom</td>
<td>11</td>
<td>Music-based intervention</td>
<td>5 x 30-min sessions.</td>
<td>SRS</td>
</tr>
<tr>
<td>Ghasemtabar, et al 2015 [21]</td>
<td>RCT</td>
<td>Iran</td>
<td>13</td>
<td>MT</td>
<td>MT Programs for 45 days in 12 sessions (2 sessions of 1 h/week)</td>
<td>No intervention</td>
</tr>
<tr>
<td>Author, Year [Ref.]</td>
<td>Design Study</td>
<td>Study Location</td>
<td>Sample</td>
<td>Treatment</td>
<td>Frequency and Duration</td>
<td>Control</td>
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<tr>
<td>Mössler, et al., 2019 [22]</td>
<td>RCT</td>
<td>Norway</td>
<td>25</td>
<td>MT</td>
<td>Low intensity: once a week High intensity: three times a week for five months.</td>
<td>Low intensity</td>
</tr>
<tr>
<td>Yoo et al., 2018 [23]</td>
<td>RCT</td>
<td>Korea</td>
<td>10</td>
<td>MT</td>
<td>8 x 30-min sessions.</td>
<td>Typical development DUACS</td>
</tr>
<tr>
<td>Schmid et al., 2020 [24]</td>
<td>RCT</td>
<td>United States</td>
<td>Before: 64</td>
<td>After: 64 80%</td>
<td>VOICSS 45 min/week for 16 week</td>
<td>Same sample after 16 weeks of intervention</td>
</tr>
<tr>
<td>Bharathi et al., 2019 [25]</td>
<td>RCT</td>
<td>India</td>
<td>Active MT: 26 Passive MT: 26 50%</td>
<td>Active and Passive MT 3 months</td>
<td>Passive Music Therapy</td>
<td>Normal developing children</td>
</tr>
<tr>
<td>LaGasse et al., 2019 [26]</td>
<td>RCT</td>
<td>United States</td>
<td>ASD: 7</td>
<td>MT</td>
<td>10 x 45-min sessions within 5 weeks</td>
<td>-</td>
</tr>
</tbody>
</table>

(-), no information; ADI-R, Autism Diagnostic Interview-Revised; ADOS, Autism Diagnostic Observation Schedule; C, control; CARS, Childhood Autism Rating Scale; DUACS, Duke University Autism Communication and Socialization; I, Intervention; MBCDI, MacArthur-Bates Communicative Development Inventories; MT, Music Therapy; SRS, Social Responsiveness Scales; SRS-PS, Social Responsiveness Scale Preschool Version; SSRS, Social Skills Rating Scale; VSEEC, Vineland Social-Emotional Early Childhood Scales
Figure 1. PRISMA flowchart for the screening and selection process.

Figure 2. Summary of the risk of bias analysis performed on the included studies.
Discussion

In this present study, we found that MT therapies have been used to manage ASD, and the outcomes have been measured through various parameters. Herein, social interaction and verbal communication skills are among the most common outcomes employed to measure the efficacy of MT therapies. Our pooled estimates revealed that the two parameters were significantly improved in groups receiving MT therapies as compared to those who did not. Collectively, the findings suggest that music yielded medical benefits for individuals with ASD. Nonetheless, our findings are contradictory with an earlier meta-analysis of music therapy for ASD individuals published in 2014, where they reported no significant improvement in social interaction in groups receiving the therapy [9]. We stipulate that this difference is attributed to the advancement in MT within the last 10 years that not only involves music hearing (passive therapy) but also other activities such as singing and instrumental playing or improvisation (active therapy) [12,16,25].
Studies regarding music-based therapy for neurorehabilitation have been widely conducted. A study showed that research in the field of music increases annually with Improvisational Music Therapy (IMT) on patients with ASD as the main discussed topic [27]. This therapy may yield its efficacy actively and passively by facilitating neuroplasticity [28]. It has been known that neuroplasticity is a process involving structural and functional brain change adaptation. This process explains how music may become a therapy for a non-musical objective [29]. Referring to the studies, MT may not only be effective in patients with ASD but also in other related neurological deficits conditions [28,29]. MT may specifically activate the right brain hemisphere that is responsible for speech, writing, tone, rhythm, and thinking [30]. Another study explained that imagining music could activate the right hemisphere area, which is also related to emotions [31]. Additionally, music universally could also provoke emotional and movement responses [21].

This study provides an updated meta-analysis on the effects of music therapy on social interaction and verbal communication skills with actual significant results within the last ten years. Our results are affected by the updated tools used to measure social interaction and verbal communication skills. Moreover, we note that the intervention has evolved to encourage more active participation in the therapy rather than just listening to the music. As limitations, we were not able to convert the scores from different measurements into a uniform score. Further, we did not perform the manual search by contacting the expert for new updates on the research.

**Conclusion**
This meta-analysis reveals significant evidence of music therapy as an option for improving social interaction and verbal communication skills by applying interprofessional healthcare collaboration. In the near future, music-based therapy may become a treatment option in the clinical setting. Further, interprofessional collaboration with the music therapist is another crucial point to achieve effective treatment. We then encourage interprofessional collaboration. Lastly, with the available technologies it is possible to carry MT for outpatients. Future research, however, is still required especially by using uniform questionnaires and recruiting a large number of patients.

**Ethics approval**
Not required.

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None.

**Competing interests**
All authors declare that they have no conflicts of interest.

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**Underlying data**
All underlying data underlying have been presented in this article.

**How to cite**
References


