Original Article

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

Shakira Amirah[1], Muhammad F. Abdurrahman[1], Raihan FA. Akbar[1] and Intan C. Mulya[2*]

[1]Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia; [2]Department of Obstetrics and Gynecology, 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,

Received: June 15, 2023 - Accepted: August 23, 2023 - Published online: August 31, 2023

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].

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.

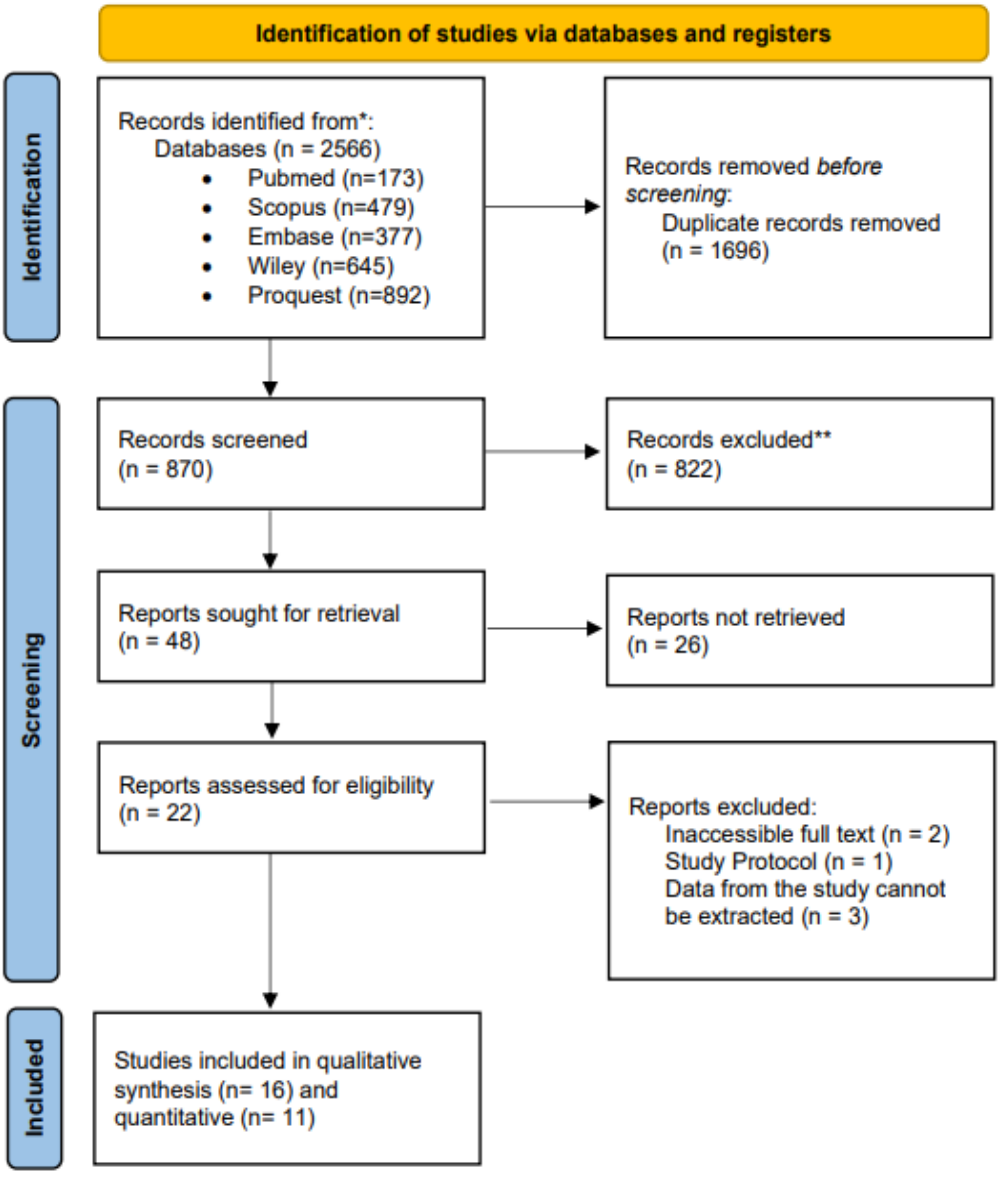

Figure 1. PRISMA flowchart for the screening and selection process.

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**.

Table 1. Characteristics of the included studies

Author, year (ref.)	Design study	Study location	Sample			Age (years)	Treatment			Qty. outcome
			Intervention	Control	Male (%)	Mean±SD	Name intervention	Frequency and duration	Control	
Sharda *et al.*, 2018 [11]	RCT	Canada	26	25	84.30%	I: 10.3±1.9 C: 10.2±1.9	MT	8–12 weeks	Non-music intervention	SRS
Bieleninik *et al.*, 2017 [12]	RCT	Norway	High intensity: 90 Low intensity: 92	182	83%	5.4	Improvisational MT	5 months	Enhanced standard care	SRS, ADOS, ADI-R
Porter *et al.*, 2016 [13]	RCT	United Kingdom	123	128	44.00%	8-16	MT and standard care	12 weekly sessions, lasting 30 min	Standard care	SSIS
Rabeyron *et al.*, 2020 [14]	RCT	France	19	18	86.10%	I: 4.9±0.8 C: 5.4±0.7	MT and standard care	8 months, 25 sessions, lasted 30 minutes of each session	Music listening	CARS
LaGasse *et al.*, 2014 [15]	RCT	Colorado	10	12	76.40%	7.6±1.1	MT	50-min session, twice a week, for 5 weeks	Social group	-
Crawford *et al.*, 2017 [16]	RCT	United Kingdom	High intensity: 90 Low intensity: 92	182	83%	5.4±0.9	Improvisational MT	High intensity: 3 x 60-min sessions/week Low intensity: 1 x 60-min sessions/week for 5 months	Standard care	ADOS, SRS
El-Tellawi *et al.*, 2022 [17]	RCT	Saudi Arabia	38	25	60.30%	6.8±3.2	Tomatis Sound Therapy	30 h (15 sessions) within three months	No intervention	CARS
Thompson *et al.*, 2013 [18]	RCT	Norway`	12	11	-	I: 43.9±6.5 C: 47.0±7.2	Family-centered MT	Once a week for 16 weeks.	Standard care	VSEEC, SRS-PS, MBCDI
Pater *et al.*, 2022 [19]	RCT	Netherland	50	-	78%	6.8	Papageno MT Program	20 music therapy sessions of approximately 40 minutes.	-	-
Pedregal *et al.*, 2021 [20]	RCT	United Kingdom	11	-	90.90%	13.3±0.9	Music-based intervention	5 x 30-min sessions.	-	SRS
Ghasemtabar *et al.*, 2015 [21]	RCT	Iran	13	14	51.80%	I: 8.9±1.4 C: 9.2±1.5	MT	MT Programs for 45 days in 12 sessions (2 sessions of 1 h/week)	No intervention	SSRS
Mössler *et al.*, 2019 [22]	RCT	Norway	25	23	81.20%	5.7±0.11	MT	Low intensity: once a week High intensity:	Low intensity	-

Author, year (ref.)	Design study	Study location	Sample			Age (years)	Treatment			Qty. outcome
			Intervention	Control	Male (%)	Mean±SD	Name intervention	Frequency and duration	Control	
								three times a week for five months.		
Yoo *et al.*, 2018 [23]	RCT	Korea	10	42	63.40%	I: 13.4±1.4 C: 13.5±0.8	MT	8 x 30-min sessions.	Typical development	-
Schmid *et al.*, 2020 [24]	RCT	United States	Before: 64	After: 64	80%	8.0±1.6	VOICSS	45 min/week for 16 week	Same sample after 16 weeks of intervention	DUACS
Bharathi *et al.*, 2019 [25]	RCT	India	Active MT: 26	Passive MT: 26	50%	9.5±2.3	Active and Passive MT	3 months	Passive Music Therapy	CARS
LaGasse *et al.*, 2019 [26]	RCT	United States	ASD: 7	TD: 7	85,7%	I: 8.4±2.9 C: 8.3±1.7	MT	10 x 45-min sessions within 5 weeks	Normal developing children	-

(-): 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

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.

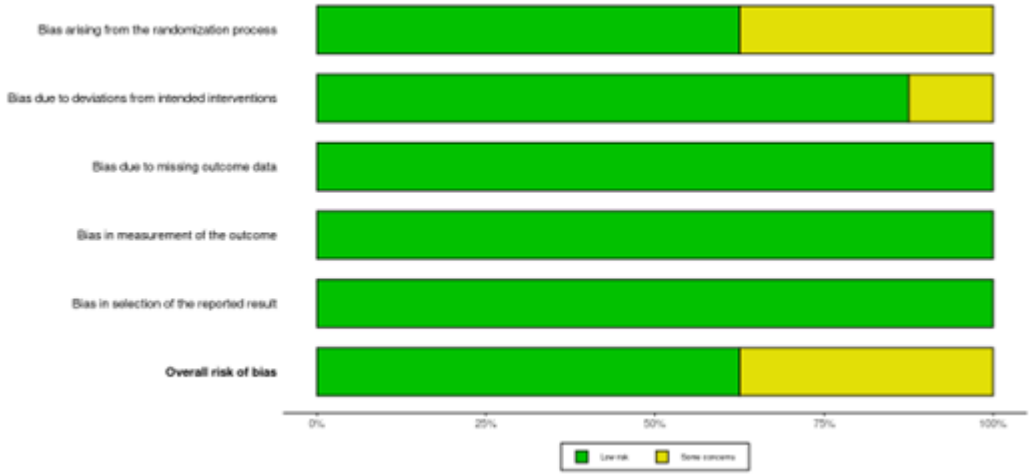

Figure 2. Summary of the risk of bias analysis performed on the included studies.

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 I^2=63%. The variation of the used questionnaire type can cause high heterogeneity.

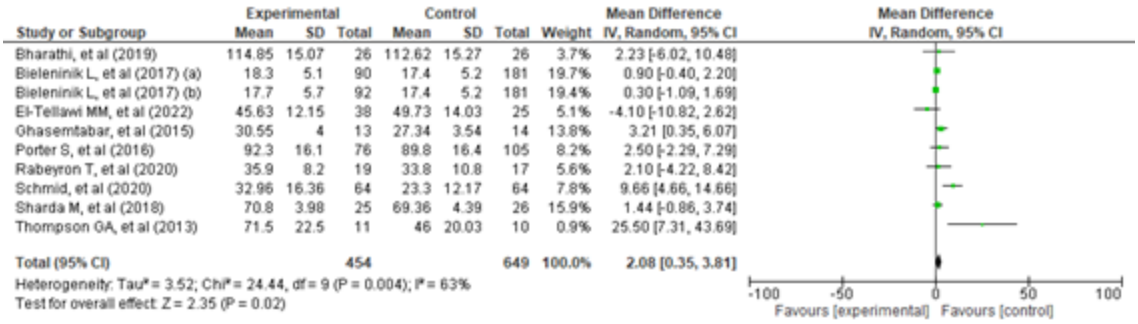

Figure 3. Meta-analysis of music therapy effectivity on social interaction.

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 I^2=53%.

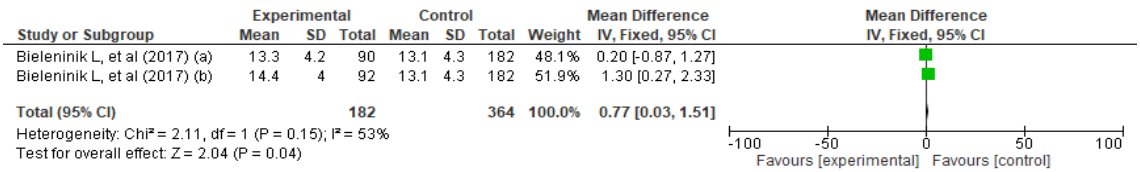

Figure 4. Meta-analysis of music therapy effectivity on social interaction (specific to ADOS questionnaire).

Meta-analysis of music therapy effecacy 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 I^2=74%, which might be attributed to different tools used in the studies.

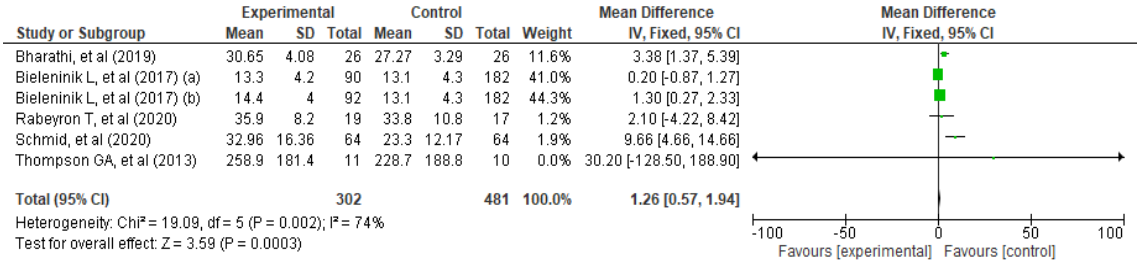

Figure 5. Meta-analysis of music therapy effectivity on verbal communication skill.

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 I^2=0%.

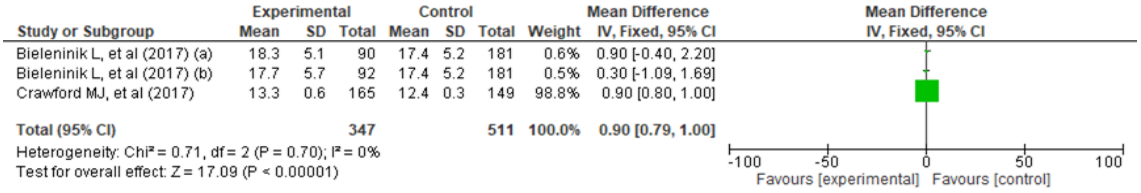

Figure 6. Meta-analysis of music therapy effectivity on social interaction (specific to ADI-R questionnaire).

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.

Acknowledgments

None.

Competing interests

All authors declare that they have no conflicts of interest.

Funding

This study received no external funding.

Underlying data

All underlying data underlying have been presented in this article.

How to cite

Amirah S, Abdurrahman MF, Akbar RFA, Mulya IC. Music therapy improves social interaction and verbal communication skill among children with autism spectrum disorder: A systematic review and meta-analysis. Narra X 2023; 1 (2): e90 - http://doi.org/10.52225/ narrax.v1i2.90.

References

1. Chiarotti F, Venerosi A. Epidemiology of autism spectrum disorders: a review of worldwide prevalence estimates since 2014. Brain Sci 2020;10(5):274.
2. Abbott AE, Nair A, Keown CL, *et al.* Patterns of atypical functional connectivity and behavioral links in autism differ between default, salience, and executive networks. Cerebral Cortex 2016;26(10):4034–4045.
3. Hodges H, Fealko C, Soares N. Autism spectrum disorder: definition, epidemiology, causes, and clinical evaluation. Transl Pediatr 2020;9(Suppl 1):S55.
4. Oswald TM, Winder-Patel B, Ruder S, *et al.* A pilot randomized controlled trial of the ACCESS program: a group intervention to improve social, adaptive functioning, stress coping, and self-determination outcomes in young adults with autism spectrum disorder. J Autism Dev Disord 2018;48:1742–1760.
5. Ford CL, Young LJ. Refining oxytocin therapy for autism: context is key. Nat Rev Neurol 2022; 18(2):67–68.

6. Marquez-Garcia AV, Magnuson J, Morris J, *et al*. Music therapy in autism spectrum disorder: A systematic review. Rev J Autism Dev Disord 2022;9:91–107.
7. Rakhymbayeva N, Amirova A, Sandygulova A. A long-term engagement with a social robot for autism therapy. Front Robot AI 2021;8:669972.
8. Reschke-Hernández AE. History of music therapy treatment interventions for children with autism. J Music Ther 2011;48(2):169–207.
9. Geretsegger M, Elefant C, Mössler KA, *et al*. Music therapy for people with autism spectrum disorder. Cochrane Database Syst Rev 2014;2014(6):CD004381.
10. IntHout J, Ioannidis JP, Borm GF. The Hartung-Knapp-Sidik-Jonkman method for random effects meta-analysis is straightforward and considerably outperforms the standard DerSimonian-Laird method. BMC Med Res Methodol 2014;14:1–12.
11. Sharda M, Silani G, Specht K, *et al*. Music therapy for children with autism: investigating social behaviour through music. Lancet Child Adolesc Health 2019;3(11):759–761.
12. Bieleninik Ł, Geretsegger M, Mössler K, *et al*. Effects of improvisational music therapy vs enhanced standard care on symptom severity among children with autism spectrum disorder: The TIME-A randomized clinical trial. JAMA 2017;318(6):525–535.
13. Porter S, McConnell T, McLaughlin K, *et al*. Music therapy for children and adolescents with behavioural and emotional problems: A randomised controlled trial. J Child Psychol Psychiatry 2017;58(5):586–594.
14. Rabeyron T, Del Canto J-PR, Carasco E, *et al*. A randomized controlled trial of 25 sessions comparing music therapy and music listening for children with autism spectrum disorder. Psychiatry Res 2020;293:113377.
15. LaGasse AB. Effects of a music therapy group intervention on enhancing social skills in children with autism. J Music Ther 2014;51(3):250–275.
16. Crawford MJ, Gold C, Odell-Miller H, *et al*. International multicentre randomised controlled trial of improvisational music therapy for children with autism spectrum disorder: TIME-A study. Health Technol Assess 2017;21(59):1–40.
17. El-Tellawy MM, Ahmad AR, Saad K, *et al*. Effect of hyperbaric oxygen therapy and tomatis sound therapy in children with autism spectrum disorder. Prog Neuropsychopharmacol Biol Psychiatry 2022;113:110457.
18. Thompson GA, Shanahan EC, Gordon I. The role of music-based parent-child play activities in supporting social engagement with children on the autism spectrum: A content analysis of parent interviews. Nord J Music Ther 2019;28(2):108–130.
19. Pater M, Spreen M, Yperen Tv. Music therapy for children on the autism spectrum: Improved social interaction observed by multiple informants across different social contexts. Nord J Music Ther 2023;32(1):29–47.
20. Pedregal CR, Heaton P. Autism, music and Alexithymia: A musical intervention to enhance emotion recognition in adolescents with ASD. Res Dev Disabil 2021;116:104040.
21. Ghasemtabar SN, Hosseini M, Fayyaz I, *et al*. Music therapy: An effective approach in improving social skills of children with autism. Adv Biomed Res 2015;4:157.
22. Mössler K, Gold C, Aßmus J, *et al*. The therapeutic relationship as predictor of change in music therapy with young children with autism spectrum disorder. J Autism Dev Disord 2019;49(7):2795–2809.
23. Yoo GE, Kim SJ. Dyadic drum playing and social skills: Implications for rhythm-mediated intervention for children with autism spectrum disorder. J Music Ther 2018;55(3):340–375.
24. Schmid L, DeMoss L, Scarbrough P, *et al*. An investigation of a classroom-based specialized music therapy model for children with autism spectrum disorder: voices together using the VOICSS™ method. Focus on Autism Other Dev Disabil 2020;35(3):176–185.
25. Bharathi G, Venugopal A, Vellingiri B. Music therapy as a therapeutic tool in improving the social skills of autistic children. Egypt J Neurol Psychiatr Neurosurg 2019;55:1–6.
26. LaGasse AB, Manning RC, Crasta JE, *et al*. Assessing the impact of music therapy on sensory gating and attention in children with autism: A pilot and feasibility study. J Music Ther 2019;56(3):287–314.
27. Li K, Weng L, Wang X. The state of music therapy studies in the past 20 years: A bibliometric analysis. Front Psychol 2021;12:697726.
28. Reybrouck M, Brattico E. Neuroplasticity beyond sounds: Neural adaptations following long-term musical aesthetic experiences. Brain Sci 2015;5(1):69–91.
29. Chatterjee D, Hegde S, Thaut M. Neural plasticity: The substratum of music-based interventions in neurorehabilitation. NeuroRehabilitation 2021;48(2):155–166.

30. Trimble M, Hesdorffer D. Music and the brain: The neuroscience of music and musical appreciation. BJPsych Int 2017;14(2):28–31.
31. Zhang Y, Chen G, Wen H, *et al*. Musical imagery involves Wernicke's area in bilateral and anti-correlated network interactions in musicians. Sci Rep 2017;7(1):17066.