

A Systematic Review of Scientific Studies on the Effects of Music Therapy on Individuals with Autism Spectrum Disorder

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Abstract

People with autism are subjected to peer rejection and social isolation from peer groups in their first three years of life due to the adverse effect autism has on everyday social and communication skills. In addition to affecting academic performance, occupational success, and mood/anxiety setbacks, social and communication deficits can negatively impact mental health, making it imperative to intervene early on to mitigate factors that could negatively affect interpersonal skills and cognitive problem-solving abilities. This review examined Music Therapy adopted to foster the quality of life among persons with autism spectrum disorder. There are 782 academic papers found in the search of relevant databases. Twelve articles met the inclusion criteria for an in-depth analysis of Music Therapy studies on people with autism spectrum disorder. Results show that five types of interventions used were traditional Music Therapy, Papageno Music Therapy Program (PMTP), Elastic touch-display, Melodyne software and Instrumental play, all positively affected persons with autism spectrum disorder. Furthermore, music therapy improves four areas of development in people with autism spectrum disorders: (a) social skills and interaction, (b) movement and coordination, (c) verbal behaviour and (d) Intelligence. Based on this review, MT was moderately effective. However, it may not apply to educational settings, social skills, interaction, movement, verbal behaviour and intelligence of people with autism. A larger sample size will be necessary to draw generalisable conclusions in future studies.

Keywords: Autism spectrum disorder, intervention, music therapy, quality of life, verbal behaviour

Introduction

Geetha et al. (2019) describe autism spectrum disorders as neurodevelopmental disorders that cause difficulties interacting socially, communicating verbally, and displaying repetitive behaviour at different levels. Various factors may contribute to autism spectrum disorder (APA, 2013). The most common challenges experienced by people with ASD are communication and interpersonal difficulties (Doreleijers et al., 2006; De Bildt et al., 2007; APA, 2013). Individuals with difficulties maintaining meaningful relationships may be negatively affected (Cohen et al., 2015). There is evidence that ASD symptoms manifest during the early stages of development and result in significant impairments in social interaction, self-help, and daily living skills (Lang et al., 2010; Horowitz et al., 2011).

It is crucial to note that ASD symptoms range in severity. The skill to perform activities requiring varying degrees of force is often impaired in children with ASD (Edwards, 2010). Notably, there may be a decrease in the accuracy of sustained force but a higher variability (Kern et al., 2011). The ability to perform tasks that require accurate timing (Edwards, 2010) and sensorimotor synchronization (i.e., coordinated actions in response to predictable external events) may also vary. In most cases, the action and the referent occur periodically, so predictability arises from the regular recurrence of the referent and the coordination of its time with an external part of the action (Repp & Su, 2013). Individuals with ASD are estimated to lack functional speech. In some cases, speech may develop, but it often does so in a restrictive or stereotypical manner (Prizant, 1996; Schlosser & Wendt, 2008). People with ASD struggle to integrate multisensory input, filter auditory information, and categorise phonemes (DePape et al., 2012). Persons with ASD often demonstrate enhanced hearing abilities (Ouimet et al., 2012), such as pitch recognition (Heaton, 2003, 2005) and pitch memory (Stanutz et al., 2014). Their responses to auditory stimuli, for instance, are delayed or advanced (LaGasse & Hardy, 2013; Staples & Reid, 2010)

Using MT in the classroom can help children with autism learn routines (Kern et al., 2007). The practice of music has been around for thousands of years (Conard et al., 2009), is widespread (Mehr et al., 2019), and is a significant part of our daily lives. As a complementary and alternative treatment, music therapy often involves singing or playing music as a group (Klein & Kemper, 2016; Jacob et al., 2021a). Thus, music is essential for

developing skills required for social interaction and non-verbal communication (Johnels et al., 2016). As a systematic intervention method, music therapy (MT) involves clients forming relationships with therapists through sharing music experiences and relationship building (Bruscia, 1998). Physical, emotional, and mental well-being are some of the most important goals of MT (Schmidt et al., 2020). Some disorders, such as personality and health-related, can be addressed through conscious and planned interventions. People with ASD can benefit from MT interventions through improved communication, cognitive and language abilities (James et al., 2015).

Children with autism can benefit from music interventions, but little research has explored how to do so. The Neurologic Music Therapy (NMT) method as a type of MT has been used with promising results to improve the motor function of persons with ASD (LaGasse & Hardy, 2013; Sanglakh et al., 2017). A variety of music therapy techniques can be employed, including (a) improvisation without boundaries, (b) improvised structured music (i.e., some established parameters for the music), (c) rehearsing or performing pre-composed songs, (d) composing songs and instrumental music, and (e) listening to music (Wheeler et al., 2005). Music therapy in special education programs can be a very effective intervention. Additionally, music contributes to an individual's biological and aesthetic development (Jensen, 2000). Emotions, ideas, and energy levels are directly affected by music.

Vocal melodies are the only ones capable of effectively communicating, despite the possibility of using musical instruments to produce them. Adult listeners are more aroused by Sung melodies than instrumental melodies, even without lyrics (Weiss et al., 2016). A music therapy program can also reduce anxiety and inhibition among learners (Merrell, 2004). Music therapists use various kinds of music to relieve psychological and physical stress (Stansell, 2005; Jacob & Pillay, 2021). According to Jacob and Pillay (2021), the effect of MT varies from individual to individual. Moreover, instrumental melodies are less memorable for adults (Weiss et al., 2017; Weiss et al., 2012) and children (Weiss et al., 2015), whose ability to speak is already apparent by the time they are about two years old (Gudmundsdottir & Trehub, 2018). Wheeler et al. (2005) suggest that pre-composed music, activities, and improvisations can benefit children with special needs. Young children lacking literacy might not benefit from songwriting, but adolescents might find it enjoyable and a valuable learning tool. Conversely, isolated receptive listening experiences seem less common (Wheeler et al. 2005).

Furthermore, MT is an effective intervention for ASD due to the expressive and communicative processes that naturally occur (Stegemann et al., 2019; Jacob et al., 2022a). Roley (2017) reports that MT effectively improves social functioning and competencies among adolescents with emotional and behavioural disorders. Similarly, Sze and Yu (2002) explain that MT contributes to the academic, cognitive, and psychosocial development of children with disabilities when appropriately accommodated. Individuals of all ages can benefit from MT in healthcare services because it addresses their emotional, cognitive, and social needs (Duerksen, 2014; Jacob et al., 2022a).

Methodology

Search Procedure

An electronic search was conducted in four databases: (a) PsycINFO, (b) MEDLINE, (c) CINAHL, and (d) ERIC. The study covered 2019-2023 since previous studies have reviewed studies from 2007-2018 (Accordino et al., 2007; Gold et al., 2006; James et al., 2015; Marquez et al., 2018). Journals only published in English were included in this review due language barrier and lack of funding for an interpreter. The terms music therapy and autism were used in all database searches (along with the relevant BOOLEAN operators).

Inclusion and Exclusion Criteria

The PRISMA screening criteria, first developed in 2000, were used for the selection of included literature (Ghafari et al., 2016; Jacob et al., 2022a; 2022b). Quantitative studies, such as experimental and quasi-experimental designs, were included in this systematic review. At least one individual with ASD had to be evaluated in the study to determine the effects of music therapy on their behaviour. To qualify for music therapy intervention, the researchers needed to meet the following criteria: (a) music therapy was used for nonmusical purposes, and (b) the article had to deal specifically with ASD. The study did not include review papers, theoretical papers, descriptive studies, or skills assessment studies. Articles not explicitly mentioning autism were generally excluded from the review. The search did not have any geographic restrictions. The study excluded 516 articles (see Figure 1). Including or excluding dissertations has no effect on literature reviews (Vickers & Smith, 2000; Jacob et al., 2022a; Jacob & Pillay, 2022).

Quality Assurance

The review removed duplicate articles for quality assurance. Inclusion in the review was determined by reviewing the abstracts of identified studies. Twelve articles were selected using the criteria for inclusion and exclusion. Independently coding 20% of the studies included ensuring the reliability of the data. The authors found 81.5% agreement in inter-rater reliability among all codes. At each stage, the literature included and excluded is illustrated in Figure 1.

Coding Categories

A code was assigned to each article according to the following factors: (a) form of disability, (b) sampling method, (c) sample, (d) instrument, (e) type of music therapy, (f) age, (g) gender, (h) duration and (e) result based on the effect of MT.

Ethics

There were no ethical considerations for this review because all articles used were freely available in the public domain.

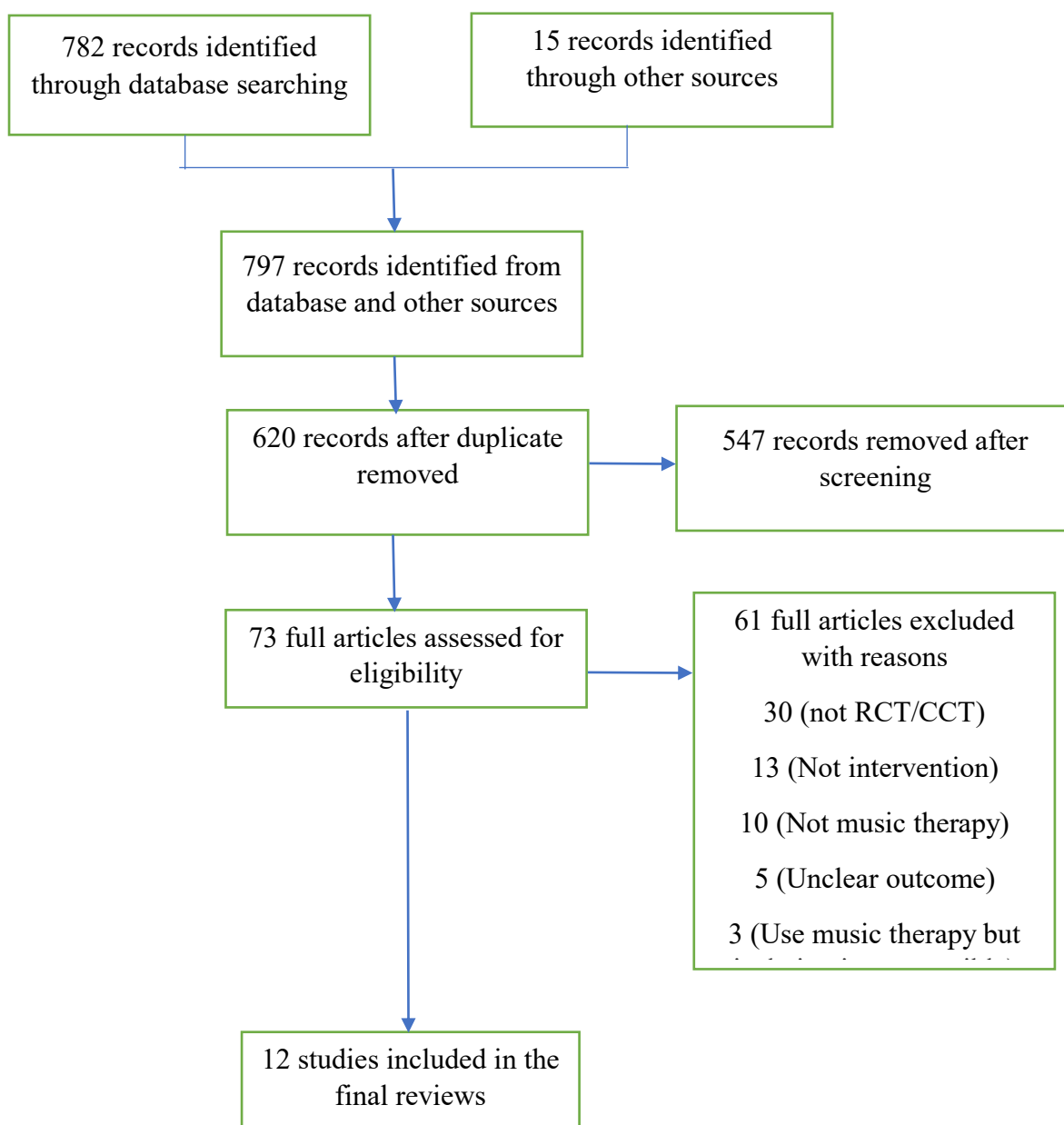


Figure 1: Flowchart of the systematic literature search

Table 1: Intervention, sampling methods and sample

Authors and year	Intervention	Form of Disability	Sampling Methods	Sample	Instrument
Rabeyron et al. (2020)	Music Therapy and Listening to Music (LT)	Autism	Randomised	37 participants	Clinical Global Impression (CGI), Abberant Behavior Checklist (ABC) & Childhood autism rating scale (CARS)
Pater et al. (2021)	Papageno Music Therapy Program' (PMTP)	Autism Spectrum Disorder getting music therapy	Convenient	10	Inventory of Social Behavior of Children (VISC) & Social Behavior Questionnaire (SBQ)
Cibrian et al. (2020)	Elastic touch-display (experimental) or tambourines (Control)	ASD	Random selection	22	Developmental Coordination Disorder Questionnaire (DCDQ)
Jamey et al. (2019)	Musical melody	Autism Spectrum Disorder	Not specified	64	Wechsler Abbreviated Scale of Intelligence II (WASI-II), Verbal (VIQ) and Performance (PIQ) scores
Vaiouli & Andeou (2020)	music therapy intervention	Autism Spectrum Disorders	Convenience	8	Pragmatics Profile of Everyday Communication Skills (PPECS) and the Communication and Symbolic Behavior Scales Developmental Profile (CSBSDP)
Shi et al (2021)	Different types of 12 visual music therapy	ASD	Purposive	7 ASD & 9 TD	functional magnetic resonance imaging (fMRI)
He (2021)	Music therapy (individual vs. Group)		Convenience	10	Childhood autism rating scale (CARS) and the autism treatment evaluation scale (ATEC)
Weiss et al. (2021)	Melodyne software (Celemony)	Autism Spectrum Disorder And Williams Syndrome	Purposive	52	Not specified
Attar et al. (2022)	Music and singing, listening, singing.	ASD	Purposive	3	Not Reported

Feng et al. (2022)	instrument play (Xylophone), customized songs composed & real-life music therapy	ASD	Purposive	16	Human-Robot-Interaction (HRI)
Pater et al. (2023)	Papageno Music Therapy Program (PMTP)	ASD	Purposive	50	Children's Social Behavior Questionnaire (CSBQ) and Social Responsiveness Scale (SRS)
Bharathi et al. (2019)	Music therapy	ASD	Random	60	TRIAD Special Skills Assessment (TSSA) & Childhood Autism Rating Scale (CARS)

Participants included in the study

Three hundred forty-eight (348) participants participated in the 12 articles included in this review, as shown in Table 1. There were 64 participants in Jamey et al. (2019), 18.4% of the study's total participants. Attar et al. (2022). number of participants at 3. Two studies had 10 participants each (He, 2021; Pater et al., 2021). Shi et al. (2021) study had two participants: Nine typically developing children and seven children with ASD. Only one study had participants with comorbid conditions: ASD and Williams Syndrome (Weiss et al., 2021). One study also had participants with high-functioning autistic children.

Sampling technique

The Table also shows the sampling techniques used for the selection of participants in the included articles. The result shows that 25.0% of the articles used convenience sampling (He, 2021; Pater et al., 2021; Vaiouli & Andeou 2020), 35.33% used purposive (Attar et al., 2022 Feng et al.,2022; Pater et al., 2023; Shi et al., 2021; Weiss et al. 2021), 25.0% of the studies included in this review used random sampling (Bharathi et al., 2019; Cibrian et al., 2020; Rabeyron et al., 2020) and 8.33% did not specify the sampling technique used in the selection of participants (Jamey et -al., 2019). The implication is that 92% of the studies stated the sampling techniques used.

Table 2: The Popular Type of Music Therapy Intervention in the Selected Articles

Authors and year	MT	PMTP	ETD	Melodyne software	Instrumental Play
Rabeyron et al. (2020)	√				
Pater et al. (2021)		√			
Cibrian et al. (2020)			√		
Jamey et al. (2019)	√				
Vaiouli & Andeou (2020)	√				
Shi et al (2021)					
He (2021)	√				
Weiss et al. (2021)				√	
Attar et al. (2022)	√				
Feng et al. (2022)					√
Pater et al. (2023)		√			
Bharathi et al. (2019)	√				

Table 2 shows different music therapies used in the studies in the selected articles. Five distinct therapies were noted in the selected articles. The result revealed that out of the 12 articles selected for the review, seven articles

(Rabeyron et al., 2020; Jamey et al., 2019; Vaiouli & Andeou, 2020) were observed to foster the traditional Music Therapy (MT) approach whether singly or in combination with other intervention as a control group. Two studies used Papageno Music Therapy Program (PMTP) (Pater et al., 2021 & Pater et al., 2023). Only one study used Elastic touch-display (ETD) as a music therapy on children with ASD (Cibrian et al.,2020).

Moreover, the instrumental play was only used in one of the selected articles, especially by Pater et al. (2023). From the result, most researchers use traditional music therapy; some even enhance the therapy in different ways. However, other emerging or innovative ones could be observed from the result of this review.

Table 3: Gender, duration, and findings of the Selected Articles

Authors and year	Age	Gender	Duration	Result
Rabeyron et al. (2020)	4-7yrs	Male 5, Female = 31	8months	Improvements in lethargy and stereotypy ABC subscales were associated with clinical improvement.
Pater et al, (2021)	Children & Adolescent	Not specified	23 weeks	The results of this study indicate that children with ASD have developed social behaviour more rapidly during music therapy sessions during the first 20 weeks. Based on additional statistical analyses, growth may be associated with intervention phases based on these aspects of the data.
Cibrian et al. (2020)	Children	Not Specified	2 months	According to the Developmental Coordination Disorder Questionnaire scores, all participants improved their coordination. The strength and timing assessments showed that participants had improved control over their movements after the intervention. A higher score was obtained by participants who used the elastic touch display in the Developmental Coordination Disorder Questionnaire.
Jamey et al. (2019)	10yrs	Males	2yrs	Memory, melodic pitch, and rhythm perception were similar between children with ASD and typically developing children. ASD participants' capacity to perceive melodic pitch was strongly correlated with their non-verbal cognitive skills. Children with ASD and typically developing children displayed similar effects of age on performance; rhythm discrimination increased with age. The severity of ASD social

					symptoms was not associated with music perception in people with ASD.
Vaiouli & Andeou (2020)	Not Specified	1 male, 7 females	16-week		After the intervention, family reports corroborate quantitative results regarding children's communication skills improvements.
Shi et al (2021)	3-7yrs	8 males & 1 females	60 seconds		A comparison between groups revealed positive activation of oxyhemoglobin in the prefrontal B and E brain regions of children with ASD and negative activation in typically developing children. There was a negative activation of oxyhemoglobin in the prefrontal F regions of children with ASD, whereas positive activation was detected in the prefrontal F regions of typically developing children.
He (2021)	5-7 years	Not specified	Not specified		Improvement by 34%, 20.3%, 20% & 11% in emotional, communication, motor coordination & cognitive ability respectively.
Weiss et al. (2021)	Children (8-12yrs) Adolescence (18yrs)	52 males	13-20s		Although the groups could distinguish between the old and the new melodies, they differed in their overall memory. However, vocal melodies showed a similar advantage. Music plays a vital role in processing socially significant auditory signals in individuals with ASD and Williams Syndrome
Attar et al. (2022)	6-7yrs	Males	10mins		Compared to the other two interventions, singing had the lowest latency. Furthermore, happiness levels during the music applied behaviour analysis (ABA) intervention ranged from neutral to happy, indicating an overall positive experience.
Feng et al. (2022)	11-14yrs	15 males & 1 females	30-60mins		The turn-taking behaviour of six out of nine participants with ASD was stable when playing music. Based on the results of automated emotion classification with Support Vector Machines, it can be concluded that Electrodermal Activity bio-signals can be

					used to detect and recognise emotional arousal in the ASD group.
Pater et al. (2023)	7yrs	39 males & 11 females	20 weeks		This study confirms the results of the researcher's previous multiple case study of ten children with ASD. There was a high level of agreement between the different informants. All informants observed progress, so the progress appears generalizable to other situations.
Bharathi et al. (2019)	6-12yrs	15 males & 15 females	3 months treatment & 3 months follow-up		Understanding/recognizing perspectives, initiating, responding to, and maintaining interactions were the most evident results of the MT intervention. Social skills scores increased significantly following the post-test covariance analysis. The paired sample t-test also showed MT's effectiveness throughout the follow-up period.

Participants age range

Table 2 presents the result on the age distribution of the respondents in the selected articles. The result revealed that 6 articles (50%) used participants that are between the age of 1 - 7yrs (Attar et al., 2022; He, 2021; Rabeyron et al., 2020; Shi et al., 2021), 16.66% used participants that are in the age bracket between 8-12 years (Jamey et al., 2019) while 8.33% used participants that are in ages 13-18yrs and the participants' age for 25.0% of the articles either describe the participants or not specified the age range (Pater et al., 2021; Cibrian et al., 2020; Vaiouli & Andeou, 2020).

Gender of participants

Six studies (50%) had male and female as participants (Bharathi et al., 2019; Feng et al., 2022; He, 2021; Pater et al., 2023; Rabeyron et al., 2020; Shi et al., 2021; Vaiouli & Andeou (2020). The study conducted by Attar et al. (2022); Jamey et al. (2019) and Weiss et al. (2021) had only males as study participants while two studies (1.6%) did not specify the gender of participants (Cibrian et al., 2020; Pater et al., 2021).

Duration of intervention

Jamey et al. (2019) conducted a study that lasted two years, the most prolonged duration. The study by Bharathi et al. (2019) adopted three months for treatment and three months for the follow-up. He (2021) description of the intervention did not include how long it lasted in weeks or months. Two study duration were in seconds without specifying how long the therapy was repeated (Shi et al., 2021; Weiss et al., 2021). The study by Rabeyron et al. (2020) was conducted for 8 months, while Cibrian et al. (2020) lasted two months. However, He (2021) did not specify the duration of the music therapy.

Table 4: Thematic Areas Investigated Along with Music Therapy

Authors and year	Social skills and interaction	Movement & Coordination	Verbal behaviour	Intelligence
Rabeyron et al. (2020)	√			
Pater et al. (2021)	V			
Cibrian et al. (2020)		√		

Jamey et al. (2019)	√	√
Vaiouli and Andeou (2020)	√	
Shi et al (2021)		√
He (2021)	√	
Weiss et al. (2021)		√
Attar et al. (2022)	√	
Feng et al. (2022)	√	
Pater et al. (2023)	√	
Bharathi et al. (2019)	√	

Target skills

Four categories of target skills were identified for intervention: (a) social skills and interaction, (b) movement and coordination, (c) verbal behaviour and (d) intelligence. Six studies involving 183 participants (Rabeyron et al., 2020; Pater et al., 2021; He, 2021; Feng et al., 2022; Pater et al., 2023; Bharathi et al., 2019) targeted the improvement of social skills and interaction, such as lethargy and stereotypy, make eye contact, focus on something together, social behaviour (social awareness, cognition and motivation). Movement and coordination were the broad focus of one study involving 22 participants (Cibrian et al., 2020).

Verbal behaviour was featured in three studies involving 75 participants (Jamey et al., 2019; Vaiouli & Andeou, 2020; Attar et al., 2022). The target skills involved increasing the function of verbal and non-verbal IQ, preverbal and verbal communication abilities and word vocally and assessing the happiness index. Three studies (Jamey et al., 2019; Shi et al., 2021; Weiss et al., 2021) with 131 participants focused on intelligence. One study (Jamey et al., 2019) targeted two skills: verbal behaviour and intelligence.

Cumulative findings

Table 3 presents different thematic areas music therapy was used on among persons with autism. The result revealed that most of the researchers have conducted studies to investigate the effect of MT on social skills and social interaction, body movement and coordination, verbal behaviour, and intelligence of persons with ASD. The cumulative findings are presented as follows:

Social Interaction Skills of persons with ASD

Out of the twelve articles included in the review, 6 investigated the effect of MT on the social and interaction skills of children with ASD. Specifically, Rabayron et al. (2020) reported an association between improvement in clinical outcomes and improvements in autistic symptoms of lethargy and stereotypy in participants with ASD. Study results suggest that MT enhances interpersonal relationships among children with ASD. Pater et al. (2023) also confirm an earlier report by Pater et al. (2021) that MT improves the social functioning of children with ASD compared to their pre-therapy developmental pace. According to the report of He (2021), there is an improvement of 34%, 20.3%, 20% & 11% in emotional, communication, motor coordination and cognitive ability, respectively, in children with ASD because of MT. For modelling and improving the responses to social situations and behaviours of children with ASD,

Feng et al. (2022) developed an innovative robot-based music-therapy platform. The results indicated that the turn-taking behaviour of six out of nine participants with ASD was stable when playing music. Pater et al. (2023) found a high level of agreement between the different informants. In general, the informants agreed. The comprehension/perspectives, starting interactions, and initiating responses subscales showed the most noticeable effects of the MT intervention (Bharathi, 2019). According to the results, all informants observed progress so that the progress may be generalizable to other situations (Pater et al., 2023). Moreover, social skills scores increased significantly after post-test covariance analysis. This implies that music therapy can be effectively used to develop social interaction skills among children with ASD.

Movement and Coordination of Children with ASD

Although there is a paucity of studies on the effects of MT on the movement and coordination of children with ASD. Out of the included articles for review, one article reported the effects of MT on the movement and coordination of children with ASD. According to the Developmental Coordination Disorder Questionnaire scores, all participants improved their coordination (Cibrian et al., 2020). This shows that there is a high probability that children with ASD will display a stable posture and movement after being exposed to music

therapy for an appropriate period. Cibrian et al. (2020) reported that the strength and timing assessments showed that participants had improved control over their movements after the intervention.

Verbal Behaviour of Children with ASD

Based on the selected articles for review, 3 out of 12 investigated the influence of MT on the verbal behaviour of children with ASD. Out of some reported findings, Jamey et al. (2019) demonstrate how MT improves preverbal and verbal communication skills among children with ASD. Children's communication skills significantly change after exposure to MT intervention (Vaiouli & Andeou, 2020). Attar et al. (2022) found that singing was associated with the lowest delay in speech among those who used MT. According to these studies, combining singing and other music therapy works better than singing alone. Moreover, it indicates the likelihood of improved verbal fluency among children with ASD after MT exposure.

Intelligence of Children with ASD

Three articles reported the effects of MT on the intelligence of children with ASD. One of the significant findings was the one reported by Weiss et al. (2021) that Children with ASD and William Syndrome exhibited higher levels of memory than children with William Syndrome. Shi et al. (2021) reported that the changes in oxyhemoglobin production differed in the brain's prefrontal lobe due to MT intervention compared to the control group. In contrast, improvement of 34%, 20.3%, 20% & 11% in emotional, communication, motor coordination & cognitive ability, respectively, in children with ASD because of MT was reported by, He (2021). This shows that music therapy influences the social interaction, coordination, verbal behaviour, and intelligence of children with ASD.

Discussion

This study aimed to evaluate the benefits of MT for individuals with ASD, assess its effectiveness, and investigate the impact of different methods on treatment outcomes. By searching databases (a) PsycINFO, (b) MEDLINE, (c) CINAHL, and (d) ERIC, the researchers examined all studies published between 2019 and 2023 that investigated the outcomes of music therapy on ASD.

The systematic review identified and analyzed 12 articles that investigated the effects of MT on individuals with ASD. Music therapy was found to have positive outcomes in 12 studies, suggesting that it may be able to help some people with ASD. It is worth noting, however, that some limitations were revealed in this research. The number of studies identified was relatively small ($n = 12$). The present examined only research conducted between 2019 and 2023, as previous reviews had examined research conducted between 1973 and 2000 (Accordino et al., 2007), 1997 and 2003 (Gold et al., 2006), 2004 and 2015 (James et al., 2015) and 2008 and 2018 (Marquez et al., 2018). However, Gold et al. (2006) identified three skills for intervention in their study, while James et al. (2015) identified five skills. The present review identified four.

The identified studies included 348 participants. The participants were between the ages of 4 and 18. Two studies identified study participants as children, children, and adolescents without specifying the age range, while one did not. The implication is that MT can be used effectively to enhance the lives of children and adolescents alike. In six studies, both men and women participated, while in three studies, the gender of participants was not specified. As for the remaining three, only males participated. This presents a significant limitation. There is also a limitation related to the quality of the method. Experiments still need to be conducted with rigour and quality.

This systematic review did not combine quantitative and qualitative findings, so there was no question about data equality. The reason is the difficulty reconciling qualitative and quantitative results (Adeniyi & Omigbodun, 2016; Jacob et al., 2021a; Jacob et al., 2021b). The study by Shi et al. (2021) was the only one that compared the effects of MT on children with ASD and children with typical development (TD). Children with ASD showed increased oxyhemoglobin production in prefrontal brain regions B and E during visual and musical tasks, while children with typical development showed a decrease in oxyhemoglobin production.

The therapies included general music therapy, the Papageno music therapy programme, elastic touch-display, instrumental play and Melodyne software to target skills, and clinical improvisation. According to the analysis of all the interventions and study outcomes, all treatments demonstrated significance in treating participants with ASD. Several studies have confirmed that evidence-based music therapy benefits children with

neurodevelopmental disorders (Lense & Camarata, 2020; Sharda et al., 2019). This review shows that various forms of MT adopted yielded positive results. Thus, music-making can take many forms in MT (Weiss et al., 2016). Children with ASD tend to engage in more social interaction using sung words than spoken words (Paul et al., 2015; Thompson & Abel, 2018).

Conclusion

This study reviewed MT delivered for persons with ASD. It is evident from this review that MT can have positive effects on individuals with ASD. Based on the 12 articles reviewed in this study, different aspects of individuals with ASD were significantly affected by the treatment, such as (a) verbal behaviour, (b) Intelligence, (c) social skills and interaction and (d) movement and coordination.

Future research should be conducted with a larger sample size to establish generalizable conclusions. Several studies have shown that MT for people with ASD are effective. Thus, our results complement other reviews about MT's benefits and relevance to individuals with ASD. Despite the review's strengths, it has several limitations. Since resources were limited, only open-access publications were included. To enhance the communication skills of people with ASD, we recommend including MT as a therapeutic intervention, where possible.

Furthermore, we adopted a reductionist approach, eliminating articles that did not relate to MT for individuals with ASD. We also excluded publications in review articles, book chapters and articles in the press. The view of others was not considered in any of the reviews, while only one of the included studies did a comparative study. Future research could take several directions. There is a clear need for more extensive, methodologically rigorous studies to determine (a) whether group MT will significantly impact individuals with ASD; (b) what type of MT is most effective in improving individuals with ASD and individuals who are typically developing, and the comparative differences in the effect. The effects of MT interventions should be evaluated based on participant characteristics (for example, due to gender differences in quality of life). Developing and validating new measures (such as those used for clinical populations) or establishing normative thresholds for existing ones may be necessary.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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