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Effectiveness of Behavioral Interventions for Autism Spectrum Disorder: A Systematic Review

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Abstract

Background: Autism Spectrum Disorder (ASD) is identified by a group of neurodevelopmental disorders. In view of the importance of, and demand for, novel behavioural interventions in autism disorder, a comprehensive evaluation of the outcomes of interventions for the ongoing impact of behavioral interventions in ASD is necessary.

Methods: A systematic search of the electronic databases including PubMed, Embase, Google Scholar, Scopus, Sciencedirect, Web of Science, and Biomed central were conducted to find evidence for the effectiveness of behavioral interventions in ASDs. The search strategy was based on exploring studies published in different global languages from the earliest to 2019 databases. In addition to the databases mentioned above, relevant studies were searched using forward and backward citation tracing.

Results: In the present review, 48 Randomized Controlled Trials (RCTs), and 44 quasi-experimental articles matched the defined evaluation criteria. Eighty-three out of 93 studies were conducted in high-income countries, the results of which raised the challenges associated with acceptability of conducting those studies in low- and middle-income countries. The majority of those studies (93.5%) were classified as having either low or medium quality. From those studies, 32 studies used integrative programs, and 30 studies used social skills development interventions. The majority of the studies were based on integrative programs designed to foster social skills. The results of the study showed that social skills development interventions were effective in changing the desired outcomes. The results showed that, regardless of the study design and the type of intervention used, the possibility of success in interventions were greater in changing the participants' social skills.

Conclusion: There were inconsistent evidence on the effectiveness of interventions in providing changes in targeted outcomes. There is a need for further investigation in behavioral interventions for ASDs. Further research is needed to understand the effectiveness of other interventions and finding quality interventions to achieve more significant results.

Key Words: Autism Spectrum Disorders, Behavioral interventions, Children, Systematic review.

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1- INTRODUCTION

Autism Spectrum Disorder is a neurodevelopmental disorder marked by social-communication impairment, restricted, repetitive and stereotyped patterns of behavior, and repetitive and stereotyped movements (1). In addition to these main features, other behavioral problems such as anxiety, depression, sleep and nutrition disorders, attention disorder, as well as self-injurious and aggressive behaviors are detected in these children (2). There has been a growing trend in the prevalence of autism. The US Centers for Disease Control and Prevention (CDC) reported a prevalence of 1 per 110 children from 2004 to 2006 (3), 1 perin 110 children in 2012 (4), and 1 per 59 children in 2014. Studies in Iran indicated an increasing trend of autism spectrum disorders in children. According to a study, the prevalence of autism disorder was 26.6 per 10,000 children in 2007 (5), and 95.2 per 10,000 children in 2014 (6).

While there is no existing treatment for autism spectrum disorder, it is generally believed that early diagnosis and treatment seem to recover many people with autism over time (7). Therefore, how different interventions could help to improve the functional ability of people with autism spectrum disorder is essential for families, health professionals, and policymakers (2). Over the past 30 years, various treatments have been suggested to alleviate and recover symptoms associated with autism spectrum disorder. Current treatments include medications, diet changes, vitamin therapy, rehabilitation therapies, as well as behavioral, and developmental interventions (8). Most interventions vary, depending on the theoretical framework, type of presentation, severity of intervention, the level of parent involvement, and comprehensive intervention used. In addition, interventions are very expensive and necessitate a large number of well-trained staff and technical infrastructure (9).

Based on the performance shown in the experimental studies, interventions included in the continuum of behavioral interventions are the dominant treatment approach to improve social, adaptive, and behavioral performance of people with autism spectrum disorder (10). These interventions are guided by a therapist and are seeking to improve social and behavioral skills in children and their families. While behavioral interventions may be provided up to long hours per week, there is a debate about the intensity needed to achieve positive outcomes and the effectiveness of different approaches (11). A comprehensive evaluation of review studies conducted on behavioral interventions in autism spectrum disorders reveals that most of these studies have methodological flaws, which is led to the weakness of their validity (2,9). We identified one review on the effectiveness of behavioral interventions for Autism Spectrum Disorder among children (2). These reviews included various designs, such as Randomized Controlled Trials (RCTs), Controlled Clinical Trials (CCTs) or observational analytical studies (i.e., prospective or retrospective cohort studies with comparison groups) and reported data on the effects of a behavioral or developmental intervention in individuals with ASD until 2008 (2). However, none of those reviews assessed the methodological quality of the included studies. There is also evidence of positive outcomes in many of the interventions conducted on autism disorder. Therefore, further investigation is required to evaluate the effectiveness of behavioral interventions for autism spectrum disorder

using rigorous scientific methods. Physicians, educators, and families of people with autism need to make informed decisions about treatment options. In this regard, clinical and research questions about the benefits of the related interventions need to be addressed and responded. Given the importance of the current increasing trend in the novel intervention programs, a detailed evaluation of the effects of interventions on the continuing impact of behavioral interventions for autism spectrum disorder will provide the necessary information for policymakers, researchers, health care providers, and families. This systematic review aimed to identify, evaluate, and integrate evidence on the effects of behavioral interventions to improve the primary symptoms associated with ASD.

2- MATERIALS AND METHODS

In the current systematic review, PRISMA checklist was used to report the findings of the study.

2-1. Search strategies

Database articles, including BioMed Central (BMC), PubMed, Sciencedirect, Embase, Web of Science, and Scopus were reviewed using the search strategy used in the related studies (2). The search strategy in the scientific databases is set out in Appendix A, and according to the search requirements at each of the databases mentioned, necessary changes were made while searching websites.

2-2. Trial selection

All articles identified from various sources were first collected by a researcher using Endnote software. After integrating the articles from all the cited databases and deleting duplicate articles, the two researchers of the current study, independently reviewed all the articles and excluded the articles that were not relevant to the subject and the inclusion criteria. The abstracts of remaining articles were independently studied by two researchers. Then, the full texts of the relevant articles were reviewed by two researchers and the articles that were fully consistent with the criteria were identified. Using forward and backward citation reviews, additional articles were added to the resource collection. Data was extracted by two researchers. At all stages, disagreements were resolved through consensus-based discussion and, finally, through the opinion of the third researcher.

2-3. Inclusion and exclusion criteria

The PICO index (study population, type of study, type of intervention, and type of outcome) was used to evaluate the inclusion and exclusion criteria (12).

Inclusion criteria encompassed the followings:

- Type of Study: Types of RCTs and Quasi-Experimental Studies (cPPI and PPI).

- Study population: Children, caregivers and families of children in all ages and both sexes who were involved with autism spectrum disorders and problems.

- Type of intervention: It included the evaluation of an intervention program at national, regional, organizational, community, or individual levels for the autism spectrum disorder.

Type of Outcomes: Studies with subjective outcomes (such as the use of questionnaires for reporting) and objective outcomes (such as the use of observation and surveys) for autism spectrum disorders.

- Study period: Studies from the first years of publication in the scientific database

- Studies published in all languages of the world.

Exclusion criteria included:

- Type of Study: Descriptive, Qualitative, Review, Structured Review, Meta-Analysis, and Protocol.

- Study population: Studies conducted in other groups with developmental problems.

- Type of Intervention: Studies performing interventions for autism spectrum disorders along with other interventions for other developmental problems.

- Type of Outcome: Studies that their results are evaluated using qualitative data and the results of the evaluation cannot be compared.

2-4. Data extraction

The final articles after reviewing were summarized in predefined tables and finally the articles were analyzed according to the goals and objectives. The information in the table included:

- Full name of the first author of the study, year of publication and country of the study

- The study design consists of two general groups of controlled trial studies and quasi-experimental studies. Quasi-experimental studies were divided into two types of controlled pretest/post-test interventions (cPPI) and pretest/post-test interventions (PPI)

- Target group of the intervention programs: Studies were investigated based on conducting on children, family and child caregivers, and a combination of child/family and caregivers.

- Sample size and its properties

- Type of Intervention: To categorize the interventions in the results, we applied the framework presented in the study of Ospina et al. who classify the interventions for autism spectrum disorder in 8 groups, including Applied Behavior Analysis interventions, Communication-focused interventions, Contemporary Applied Behavior Analysis interventions, Developmental approaches, Environmental modification programs, Integrative programs, Sensory-motor interventions and Social skills development interventions (2).

- Duration of intervention and follow-up

- Models and theories used

- Results of the studies: The studies were evaluated in terms of achieving results and reported as significant, increase of positive percentages, and increase of favorable cases and decrease of unfavorable cases.

2-5. Quality assessment

In order to determine the quality of the articles, two trained researchers reviewed the articles. To evaluate the quality of the studies, the EPHPP tool developed by the National Collaboration Center for Methods and Tools (NCCMT) was used for all types of studies (13). Based on this tool, one of the qualities, i.e., strong, medium and poor were considered for each of the articles. The quality assessment in this tool is based on an evaluation of 6 components, including sample selection bias, type of study, confounders, blinding, data collection methods, and sample dropout and exclusion. The quality assessment of the studies based on the tools was separately carried out by two researchers and finally, to determine the quality of the studies, the disagreement between the two researchers was resolved by consensus-based discussions. Kappa coefficient was used to evaluate the agreement between the two evaluators (14). No studies were excluded due to poor quality.

3- RESULTS

A total of 37200 references were identified and reviewed: 36990 references from the main sources, and 210 references from other sources. From these references, 1290 were selected for abstract review. After in-depth abstract review of the abstracts, 365 references met the inclusion criteria and were selected for full review.

Eventually, after ensuring that inclusion criteria were satisfied, 93 studies were included in this review (See Fig. 1).

A summary of the included articles is provided in Table 1.

Table-1: Effectiveness of behavioral interventions for Autism Spectrum Disorder

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Acaret al., 2016/ Turkey	PPI	N= 3 children I: n =3	Mother-developed and delivered social stories and videos, modeling in teaching social skills, sessions once a day in three consecutive days at the house of each dyad	-100% response rate - Immediate follow-up by observation -No theoretical model	- Social Skills	- Interventions were effective in teaching social skills to children	Weak
Yoo et al., 2018/ Korea	PPI	N= 9 children I: n =9	Preliminary pilot of a rhythm-mediated music therapy intervention measured changes in social skills. Each participant received a total of eight 30-minute individual sessions	-100% response rate - Immediate follow-up by observation - No theoretical model	- Joint engagement	- Greater engagement in joint action following the intervention	Weak
Stavrou et al., 2018/ USA	PPI	N= 7 children I: n =7	The program was 12 weeks, at a frequency of 3 sessions per week of 40-45 minutes	-100% response rate - Immediate follow-up by observation	-Communication and behavior skill	- Significant improvement in communication and	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
			each time.	- No theoretical model		behavior skill	
Cardoso et al., 2010/ Brazil	cPPI	N= 16 children I: n = 8 C: n = 8	Once a week, specialized language therapy by a speech-language pathologist for a period of at least six months	-100% response rate - Immediate follow-up by observation - No theoretical model	- Social cognitive profile and the Social-Communicative adaptation	- No significant statistical improvemnent in the social cognitive profile	Weak
Choque Olsson et al., 2017/ Sweden	cPPI	N= 296 children I: n = 150 C: n = 146	Twelve sessions of manualized Social skills; group trainings ("KONTAKT") were delivered by regular clinical staff.	-71.95% response rate - A 3-month follow-up by self-report - No theoretical model	- Social Skills	- Significant statistical changes in the Social skills	Weak
Yuan &ShingIp 2018/ Hong	cPPI	N= 72 children I: n = 36	A researcher-developed VR-enabled training program to examine its efficacy on	-100% response rate - Un-known follow-up by observation	- Emotional and social skills	- improvemnent in emotion expression and social skill	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Kong		C: n = 36	emotional and social skills with six VR scenarios depicting the daily lives of typical children	- No theoretical model			
Yoder & Stone 2006/ USA	RCT	N= 36 children I: n = 19 C: n = 17	Three 20-min interventional sessions per week for 6 months	-100% response rate - Immediate follow-up by observation - No theoretical model	- Communication skills	- Significant statistical improvementss in the communication skills	Moderate
Adamset al., 2012/ UK	RCT	N= 88 children I: n = 59 C: n = 29	Children in the social communication condition received up to 20 sessions of direct intervention from a specialist in speech and language therapy working with supervised assistants.	-96.6% response rate - Immediate and 3-month follow-up by observation - No theoretical model	- Social Communication and speech therapy	- No significant improvement instructural language ability or for a measure of narrative ability. - Significant improvement in social communication	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Adibsereshki et al., 2015/ Iran	cPPI	N= 24 children I: n = 12 C: n = 12	3 times a week for 15 sessions of ToM training	-100% response rate - Un-known follow-up by self- report - Theory of Mind	- Social Skills	- Social skills in the experimental group were significantly more than those in the control group	Moderate
Waugh and Peskin 2015/ Canada	RCT	N= 49 children I1: n = 19 I1: n = 11 C: n = 19	Children were taught to identify and consider their peer's mental states, while learning friendship-making skills and strategies, through the use of visual scaffolds in story format.	-95.9% response rate - 3-month follow-up by observation - Theory of Mind	- Social Skills	- Social skills in the experimental groups were significantly more than those in the control group	Moderate
Welterlin et al., 2012/ USA	PPI	N= 20 parent and children I: n = 20	2 weeks of Home Teaching Program	-100% response rate - A 4-month follow-up by observation - No theoretical model	- Child and parent behavior	- Robust support for improvement in child and parent behavior but not significant	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Roberts et al., 2011/Australia	RCT	N= 85 children I1: n = 28 I1: n = 28 C: n = 29	12-month of an individualized home-based program (HB), a small group center-based program for children combined with a parent training and support group (CB)	-98.8% response rate - 6-month follow-up by observation - No theoretical model	-Social and communication skill development	- Children in the CB and HB group improved significantly more in social and communication measures.	Moderate
Albasha et al., 2016/ USA	PPI	N= 9 children I: n = 9	Each child attended one, 25-minute session per week for 8 weeks. The children were assigned to have their first 4 weeks with the dog and the next 4 with the human proxy, or vice versa.	-100% response rate - A 1-month follow-up by observation - No theoretical model	- Social initiation behaviors	- No significant effect on social initiation behaviors	Weak
Wright et al., 2016/ USA	RCT	N= 50 children I: n = 25	Goal-setting session followed by an annualized toolkit for creating Social Stories™	-100% response rate - Un-known follow-up by self-report	- Behavior and social skills	- High levels of completion rates and they appeared to be	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
		C: n = 25		- No theoretical model		capturing social and behavior skills targeted by the use of social stories.	
Wong 2013/ USA	RCT	N= 33 teacher and children I1: n = 10 I2: n = 14 C: n = 9	-I: in three groups: (1) symbolic play then joint attention intervention, (2) joint attention then symbolic intervention, and (3) control group - Teachers participated in eight weekly individualized 1-h sessions	-100% response rate - Un-known follow-up by observation - No theory and model	- Play and joint attention	- significant imrovemnets among teachers in the implementation of an intervention - Improvement in joint engagement - significant increases in joint attention and symbolic play skills	Moderate
Vernon et al., 2019/ USA	RCT	N= 28 parent and children	6 months (26 weeks) of the PRISM treatment model. The intervention sesseions were 10	-82.1% response rate - Un-known follow-up by observation	- Social motivation	- Effective Pivotal response treatment for social motivation in	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
		I: n = 10 C: n = 9	h a week: 8 h of one-on-one clinician-implemented treatment and 2 h of parent education in the intervention strategies with the presence of the child	- Social Motivation model		children	
Wood et al., 2017/ Australia	PPI	N= 45 children I: n = 45	An average 20 hr. of intervention per week for 24 months	-71.1% response rate - Un-known follow-up by observation - No theory and model	- Expressive language, cognitive behavior skills	- Statistically significant increases in receptive and expressive language, cognitive, and adaptive behavior skills	Weak
Woo and Leon 2013/ USA	RCT	N= 28 children I: n = 15 C: n = 13	Daily olfactory/tactile stimulation along with exercises that stimulated other paired sensory modalities	-100% response rate - 6-month follow-up by observation - No theory and model	- Environmental enrichment	- Significant gains in environmental enrichment	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Woo et al., 2015/ USA	RCT	N= 50 parent and children I: n = 22 C: n = 28	Participants received daily sensorimotor enrichment, administered by their parents, along with standard care	-100% response rate - 6-month follow-up by observation - No theory and model	-Environmental enrichment	- Significant gains in their IQ scores, a decline in their atypical sensory responses, and an improvement in their receptive language performance	Moderate
Willemin et al., 2018/ Germany	PPI	N= 14 children I: n = 14	Social-emotional training during eight one-hour sessions of a novel dyadic within-group drumming program called drumtastic at a four-week summer camp	-100% response rate - A 6-month follow-up by observation - No theory and model	- Social emotion	- significantly higher scores in Smiley-o-meter, and fun-o-meter - No statisticat significant change in children's social and personal skills.	Weak
Alzrayer	PPI	N= 4	An Apple iPad II1 with	-100% response rate	- Communication	- Participants were	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
et al. 2017/ USA		children I: n = 4	Proloquo2Go software was used for navigation and symbol combination skills across three consecutive sessions	- Immediate follow-up by observation - No theory and model	skill	successful to varying degrees in navigating across pages and combining symbols to request preferred items.	
Andrews et al., 2013/ Australia	RCT	N= 58 children I: n = 29 C: n = 29	Training in greater use of visual content; parents were included in the program, and experiential learning was focused through role plays	-98.3% response rate - A 3-month follow-up by observation - No theory and model	- Affectionate communication and friendship skills	- Significantly greater improvements in the overall appropriateness of their affectionate behavior	Moderate
Wetherby and Woods 2006/ USA	PPI	N= 4 children I: n = 4	Trainings by five research assistants-four certified as speech-language pathologists and one early childhood education specialist	-100% response rate - Immediate follow-up by observation - No theory and model	- Social communication	- Significant improvement in 11 of 13 social communication measures	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Herbrecht Et al., 2009/ Germany	PPI	N= 17 children I: n = 17	Treatment according to the annualized Frankfurt Social Skills Training (KONTAKT).	-100% response rate - Un-known follow-up by observation - No theory and model	- Social and communication skills	- Significant improvement in language skills and social skills	Weak
Beaudoin et al., 2019/ Canada	RCT	N= 19 children I: n = 9 C: n = 10	A 12-week parent-mediated intervention	-100% response rate - A 3-month follow-up by observation - No theory and model	- Parent-child engagement and behavioral outcomes	- Improved toddlers' motor skills and a trend toward improvement in social adaptive behaviors - Improved parent-child engagement during the intervention	Moderate
Laugeson et al., 2014/ USA	RCT	N= 73 children I: n = 40 C: n = 33	Participants were assigned to the PEERSÒ treatment condition or an alternative social skills curriculum. Instruction was provided daily	-100% response rate - Un-known follow-up by Self-report - No theory and model	- Social skills	- Significant improvement in social skills, knowledge and frequency of hosted and invited get-	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
			by classroom teachers and teacher aides for14 weeks.			together with friends	
Guivarch et al., 2017/ France	PPI	N= 17 children I: n = 17	strategy games, board games, and individual games that were transformed into cooperative games	-100% response rate - 22-week follow-up by observation - No theory and model	- Social skills	- A significant increase in overall adaptation and social skills	Weak
Wichnick-Gillis et al., 2016/ USA	PPI	N= 3 children I: n = 3	During a given teaching session, printed scripts were superimposed upon the five teaching stimuli.	-100% response rate - Immediate follow-up by observation - No theory and model	- Social interaction skills	- A significant increase in social interaction skills	Weak
Begeer et al., 2011/ Netherlands	RCT	N= 36 children I: n = 19 C: n = 17	includes 16 weekly sessions of approximately 1, 5 h each, provided to 5 or 6 children simultaneously, with a mutual age difference that does not exceed 3 years.	-95.9% response rate - Between 6 and 12 weeks later follow-up by self-report - Theory of Mind	- Social behavior	- Self reported empathic skills and orparent reported social behavior did not improve.	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Beaumont and Sofronoff 2008/ USA	RCT	N= 49 parent and children I: n = 26 C: n = 23	Group therapy sessions, using Junior detective computer game, were conducted to facilitate participants' generalization of computer game content and teach additional social and problem-solving skills.	-100% response rate - 22 weeks follow-up by observation - No theory and model	- Social skills	- Greater improvements in social skills - Significant improvements in social functioning	Moderate
Dekker et al., 2019/ Netherlands	RCT	N= 122 children I1: n = 47 I2: n = 51 C: n = 24	including 15-session social skills training (SST) with and without parent and teacher involvement	-85.5% response rate - Immediate and 6 month follow-up by observation - No theory and model	- Social skills	- A significant increase in social interaction skills	Moderate
Wichnick et al., 2010/ USA	PPI	N= 3 children I: n = 3	- When teaching sessions began, voice-over-recording devices with pre-recorded scripts were added to seven of	-100% response rate - Immediate follow-up by observation - No theory and model	- Social interaction skills	- The script-fading procedure increased unscripted and novel initiations in peers	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
			the 10 bags containing pairs of toys				
Alzrayer 2019 USA	PPI	N= 3 children I: n = 3	Use of systematic instruction on teaching multistep social communication skills using an iPad® loaded with Proloquo2Go™	-100% response rate - Immediate follow-up by observation - No theory and model	- Social Communication Skills	- The participants were successful in using the iPad® to perform a multistep sequence in requesting - Able to acquire social communication skills	Weak
Ichikawa et al., 2013 Japan	RCT	N= 11 parent and children I: n = 5 C: n = 6	The program involved comprehensive group intervention and featured weekly 2-hour sessions, totaling 20 sessions over six months	-100% response rate - Un-known follow-up by observation - No theoretical model	-Social skills	- The outcome measurements revealed more improvements in social skills in the program group	Moderate
White et al.,	PPI	N= 15	Completed a 16-week	-100% response rate	- Social skills	- Significant	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
2010/ USA		children I: n = 15	outpatient group-based intervention.	- A 3-month follow-up by observation - Social learning theory		improvement based on social skills	
Conner et al., 2018/ USA	PPI	N= 17 children I: n = 17	consists of a 16-week individual therapy treatment targeting emotion regulation impairments	-100% response rate - Un-known follow-up by self-report - No theoretical model	- Emotional awareness and skills enhancement	- Significant improvement in emotion regulation impairments and related concerns.	Weak
Pfeiffer et al., 2013/ USA	RCT	N= 37 parent and children I: n = 20 C: n = 17	receive individual sessions with an occupational therapy graduate student under the direct supervision of an experienced occupational therapist	-100% response rate - Un-known follow-up by observation - No theoretical model	- Social responsiveness, sensory processing, functional motor skills, and social-emotional factors	- Significant positive changes in goal attainment scaling scores - No other results were significant	Moderate
Bharathi et al., 2019/	cPPI	N= 52 children	Each song was played using a CD player for 6 min. After	-100% response rate - 3 month follow-up by	- Social skills	- Significant increase in social skills' scores	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
India		I: n = 26 C:n= 26	playing the songs, the group was observed in silence for 10 min. Each session lasted for 35 min and three sessions were carried out in a week	self-report - No theoretical model			
Chiang et al.,2016/ Taiwan	cPPI	N= 34 parent and children I: n = 18 C:n= 16	The program consisted of 20 sessions, 60 min per session, twice a week, for the target child and his or her parent.	-100% response rate - 3-month follow-up by observation - Theory of Mind	- Joint engagement	- Child-initiated supportive and coordinated joint engagement was greater for the intervention group	Weak
Whitehouse et al., 2017/ Australia	RCT	N= 80 parent and children I: n = 39 C: n = 41	I: Therapy Outcomes By You (TOBY) is an app-based learning curriculum designed for children and parents as a complement to early behavioral intervention.	-94% response rate - 3 and 6 month follow-up by observation - No theoretical model	- Behavioral skill	- There was no group difference in scores on the primary outcome - Significant improvements in the TOBY	Strong

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
			Therapy Outcomes By You (TOBY therapy) at least 20 min/day for a period of 6 months			intervention group relative to the treatment-as-usual group on three secondary outcomes	
Gengouxet al., 2019/ USA	PPI	N= 22 parent and children I: n = 22	Primary caregiver participated in 12 weekly sessions of developmental reciprocity treatment parent training,	-100% response rate - Un-known follow-up by observation - No theoretical model	-Developmental reciprocity treatment	- Improvements in aspects of parent empowerment and social quality of life. - Improvement in core autism symptoms was observed on the social responsiveness - No change in sensory sensitivity was observed on the Short Sensory Profile.	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Wetherby et al., 2014/ USA	RCT	N= 82 parent and children I: n = 42 C: n = 40	Training focused on teaching parents the importance of intensive intervention and how to support active engagement in natural environments.	-100% response rate - 9 month follow-up By observation - No theoretical model	- Social communication, autism symptom, adaptive behavior	- Differential efficacy on a parent report measure of communication, daily living, and social skills, as they showed improvement or stability	Moderate
Radley et al., 2014/ USA	PPI	N= 3 children I: n = 3	10 social skills training sessions over five weeks, with social skills lessons targeting participation, conversation, perspective taking, and problem solving skills	-100% response rate - Immediate follow-up by observation - No theoretical model	- Social skill	- Improvements in skill accuracy in both of the training and generalization settings	Weak
Sansosti and Powell-Smith. 2008/	PPI	N= 3 children I: n = 3	Multiple baselines across-participants' design, computer-presented social	-100% response rate - 2-week follow-up by observation	- Social Communication Skills	- Improvements in the rates of social communication	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
USA			stories and video models were implemented	- No theoretical model			
Begeer et al., 2015/ Netherlands	RCT	N= 101 children I: n = 53 C: n = 48	- Use of The "Mini ToM intervention" in eight sessions of approximately 1 hr. for groups of five to six children	-96% response rate - A 6-month follow-up by self- report - Theory of Mind	- Emotion understanding, social skills and social behavior	- Positive effects on emotion understanding, conceptual social and autistic traits, but not on social behavior	Moderate
Katagiri 2002/ Japan	PPI	N= 12 children I: n = 12	Trainings on the selected emotions using verbal instructions alone, background music specially composed songs about emotions	-100% response rate - Un-known follow-up by observation - No theoretical model	- Emotional understanding	- Significant improvement in emotional understanding	Weak
Solomon et al., 2007/ USA	PPI	N= 68 parent and children	- Half-day (3-4 hour) visits to families' homes to teach parents how to provide	-100% response rate - Un-known follow-up by observation	- Functional emotional	- Significant increases in functional emotional skills	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
		I: n = 68	intensive, one-on-one, play-based services.	- DIR theory			
Baghdadli et al., 2013/ Franc	RCT	N= 14 children I: n = 7 C: n = 7	weekly meetings of 1 h and 30 min for a total of 20 sessions (6 months). It proposed explicit training in social skills using techniques such as video modeling, social scenarios, problem-solving exercises and role-play	-93% response rate - 6-month follow-up by observation - No theoretical model	- Social skill	- Intervention group made fewer errors in labeling anger on adult faces	Strong
Becker et al., 2017/ USA	RCT	N= 31 children I: n = 17 C: n = 14	12 weeks of weekly treatment. In the experimental condition, participants' interacted with the dogs based on the stage of the session and the sessions' target skill.	-96% response rate - 6 month follow-up by observation - Theory of Mind	- Social skills	- Significantly less symptomatic in intervention group - No significant differences were observed in the Social Language	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
						Development Test	
Kasari et al., 2014/ Nigeria	RCT	N= 51 children I: n = 30 C: n = 31	The intervention consisted of 2 stages. In stage 1, all children received 2 sessions per week for 3 months. Stage 2 dealt with the use of speech generating device	-90.2% response rate - 3 and 6 month follow-up by observation - No theoretical model	-Communicative utterances	- Improvements in spontaneous communicative utterances and novel words outcomes	Strong
Brian et al., 2017/ Canada	RCT	N= 62 parent and children I: n = 30 C: n = 32	Social ABCs coaching by one of the five coaches. During the coaching, the parents were supported to learn the techniques in the context of play. IThe intervention included 12 weeks of 1.5-hr home visits with tapering intensity.	-90.2% response - 12 and 24 weeks of follow-up by self-report rate - No theoretical model	- Social orienting	- Significant increases in child smiling and social orienting. - Significant gains in self-efficacy following the intervention	Strong
Enav et al.,	RCT	N= 68	Workshops were conducted	-100% response rate	- Emotion	- The parents reported	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
2019/ Switzerland		parent and children I: n = 38 C: n = 30	once a week for 90 min for 4 consecutive weeks.	- 3-month follow-up by observation - No theoretical model	regulation	decreased behavioral and emotional symptoms in their children, and greater parental self-efficacy.	
Drew et al., 2002/ UK	RCT	N= 12 parent and children I: n = 12 C: n = 24	Parents were visited at home by a speech and language therapist every 6 weeks for a 3-hour session. Table games gradually increased to 15–20 minutes daily. Activities were designed to take between 30 and 60 minutes “set aside” time.	-100% response rate - A 12-month follow-up by observation - No theoretical model	- Development of joint attention skills and joint action routines	- Progress in language development	Moderate
Kasari et al., 2012/ USA	RCT	N= 60 children I: n = 30	12 sessions over 6 weeks	-98% response rate - A 3-month follow-up by observation	- Social skills	- Significant improvements in social network	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
		C: n = 30		- No theoretical model		salience, number of friendship nominations, teacher report of social skills in the classroom	
Howlin et al., 2007/ UK	RCT	N= 88 children and teacher I1: n = 30 I2: n = 29 C: n = 29	A 2-day workshop for teachers plus 6 half-day, school-based training sessions with expert consultants over 5 months	-94.3% response rate - 1 and 5-month follow-up by observation - No theoretical model	- Communicative initiations and reciprocal social interaction	- Significant improvement in reciprocal social interaction - No change in frequency of speech, or improvements in language test scores.	Moderate
Lorenzo et al., 2019/ Spain	cPPI	N= 11 children I: n = 6 C:n= 5	The experimental group worked with different augmented reality activities such as a player who had to	-100% response rate - Un-known follow-up by observation - No theoretical model	- Social skills	- Significant improvement in social skills	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
			score a goal; playing with a cow. The intervention lasted for 20 weeks, in 15 min sessions twice a week				
Didehbani et al., 2016/ USA	PPI	N= 30 children I: n = 30	Completed 10, 1-h sessions across 5 weeks. It provided realistic and dynamic opportunities to engage in, practice, and attain immediate feedback on relevant and true-to-life social scenarios.	-100% response rate - Two weeks of follow-up by self- report - No theoretical model	- Emotion recognition, social attribution, attention and executive function	- Improvements on measures of emotion recognition, social attribution, and executive function	Weak
Weiss et al., 2018/ Canada	RCT	N= 68 children I: n = 35 C: n = 33	including 10 sessions of manualized, individual tCBT. Employed a group-based spy-themed curriculum to address social skills and select computer games, use of the	-72% response rate - Ten weeks of follow-up by self- report - No theoretical model	- Emotion regulation	- Significant improvements on measures of emotion regulation	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
			emotion education activities, and use of code cards.				
Corbett et al., 2016/ USA	RCT	N= 30 children I: n = 17 C: n = 13	The intervention was delivered over 10 4-h sessions, after receiving the treatment.	-96% response rate - A 2-month follow-up by observation - Theory of Mind	- Communication symptoms	- Significant improvements in measures of communication symptoms	Moderate
Bradshaw et al., 2017/ USA	PPI	N= 6 parent and children I: n = 6	weekly 1-h parent coaching sessions with a primary caregiver over a period of 12 consecutive weeks	-100% response rate - Immediate follow-up by observation - No theoretical model	- Expressive communication	- Verbal communication improved	Weak
Mitchell et al., 2015/ USA	PPI	N= 20 children I: n = 20	A 6-week program; children participated in multiple activities, including social skills groups, group discussions, skills and drills sessions, recreational	-100% response rate - 6 weeks of follow-up by observation - No theoretical model	- Daily behavior and social skills	- Daily behavior and social skills improved	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
			activities, art and academic classroom time, and yoga				
Cotugno 2009/ USA	PPI	N= 18 children I: n = 18	30 weeks of training in social competence and social skills	-100% response rate - 6 weeks follow-up by observation - No theoretical model	- Anxiety management, joint attention, and flexibility/transitions	- Significant improvement in the areas of anxiety management, joint attention, and flexibility/transitions	Weak
DeRosieret al.,2011/ USA	RCT	N= 55 parent and children I: n = 27 C: n = 28	fifteen 60-minute group sessions during consecutive weeks; parents attended and participated in four of the sessions with their child.	-100% response rate - A 2-week follow-up by self- report - No theory and model	- Social skills	- Significantly greater mastery in social skills - Parents reported an improved sense of social self-efficacy	Moderate
Fteiha 2017/ United Arab Emirates	RCT	N= 12 parent and children I1: n = 4	- Group 1: trained each child separately using CompuThera Program. - Group 2: trained each	-100% response rate - Un-known follow-up by observation - No theoretical model	- Language skills	- Interventional Groups enjoyed significantly greater gains in language	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
		I2: n = 4 C: n = 4	child separately using Language Master - Group 3(control): applied the ordinary program applied in the center using the traditional linguistic training.			scores than those in the control group	
Rollins et al., 2016/ USA	PPI	N= 4 parent and children I: n = 4	Weekly home visits and worked with caregivers to establish and maintain face-to-face reciprocal social interaction and eye contact. Each session included a 10-min video of parent–child interaction	-100% response rate - Immediate follow-up by self-report - No theoretical model	- Social interaction and eye contact	- The intervention was effective for the measures of eye contact, social engagement, and verbal reciprocity but not for nonverbal turn taking.	Weak
Hutchins and Prelock2013/ USA	PPI	N= 20 children I: n = 20	Using daily behavior stories and communication stories	-100% response rate - A 6-week follow-up by observation	- Problem behaviors and communication	- The intervention was effective for Problem behaviors and	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
				- No theoretical model		communication	
Hamdan et al., 2018/ Amman	cPPI	N= 26 children I: n = 13 C: n = 13	36 training session, 3 sessions a week, 35 minutes for each session.	-100% response rate - Un-known follow-up by observation - No theoretical model	- Non-verbal communication skills and eye contact, imitation	- Significant improvement in non-verbal communication skills - There was no change in other fields	Weak
Drahota et al., 2011/ USA	RCT	N= 40 children I: n = 17 C: n = 23	Therapists worked with children and families during 16 weekly sessions, each lasting 90 min (about 30 min with the child and 60 min with the parents/family)	-100% response rate - A 3- month follow-up by observation - No theoretical model	- Daily living skills and related parental intrusiveness	- Parents reported increases in children's total and personal daily living skills, and reduced involvement in their children's private daily routines.	Moderate
Reitzel et al., 2013/ Canada	RCT	N= 26 parent and children	- Intervention group received functional behavioral skills training for 4 months and the	-57.7% response rate - A 2-month follow-up by observation	- Functional skills and communication	- Improved in targeted functional skills and communication	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
		I: n = 14 C: n = 12	control group received the usual treatment.	- No theoretical model			
Scahill et al., 2016/ USA	RCT	N= 180 parent and children I: n = 89 C: n = 91	Training included specific strategies to manage disruptive behavior over 11 to 13 sessions, 2 telephone boosters, and 2 home visits.	-96.6% response rate - 24 weeks of follow-up by observation - No theoretical model	- Daily living skills	- Improvement in daily living skills	Moderate
Lopata et al., 2006/ USA	PPI	N= 21 children I: n = 21	For 5 days per week, 6 hours each day for 6 weeks, all participants received three identical core treatment components targeting at social behaviors, including intensive social skills instruction, face-affect recognition, and interest expansion.	-100% response rate - Un-known follow-up by observation - No theoretical model	- Instruction on social skills and social behaviors	- Significant improvement in social skills - Significant improvement in adaptability and reduction in unusual behaviors	Weak
Kamps et al.,	RCT	N= 95	consisted of games and age-	-89.5% response rate	- Social and	- Significant	Moderate

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
2015/ USA		teacher and children I: n = 56 C: n = 39	appropriate table-top play activities (e.g., card games, popular board games).	- Un-known follow-up by observation - No theoretical model	communication skills	improvement in social skills - Significant growth for total communications	
Lim 2010/ USA	RCT	N= 50 children I1: n = 18 I2: n = 18 C: n = 14	I1: music training watched a music video containing 6 songs and picturesof the 36 target words; I2: speech training watched a speech video containing 6 stories and pictures	-89.5% response rate - Un-known follow-up by observation - No theoretical model	- Language skills	- Significant improvement in verbal production and functional speech	Moderate
Edgerton 1994/ USA	PPI	N= 11 children I: n = 11	individual improvisational music therapy sessions for a period of 10 weeks	-100% response rate - Un-known follow-up by observation - No theoretical model	- Communicative behaviors	- Improvisational music therapy for increasing autistic children's communicative	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
						behaviors	
Schertz et al., 2018/ USA	RCT	N= 144 children I: n = 73 C: n = 71	weekly 1-h home-based sessions for 32 weeks	-100% response rate - A 6-month follow-up by observation - No theoretical model	- Social communication	- Significant improvement in social communication	Weak
Kaale et al., 2012/ USA	RCT	N= 61 children I: n = 34 C: n = 27	- I: 8 weeks of joint attention and intervention, in addition to their preschool programs - C: 8 weeks of engagement and intervention, in addition to their preschool programs	-100% response rate - 12 months of follow-up by observation - No theoretical model	- Joint attention and joint engagement	- Significant improvement in the Joint attention group	Moderate
O'Haire et al., 2014/ Australia	cPPI	N= 64 children I: n = 37 C: n = 27	The Animal-Assisted Activities program during 8 weeks of animal exposure performed in the school classroom in addition to 16 20-minute animal-	-100% response rate - A 2-month follow-up by self-report - No theoretical model	- Social functioning	- Significant improvements in social functioning,	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
			interaction sessions				
Frankel et al., 2010/ USA	RCT	N= 68 children n = 35 C: n = 33	Targeted skills included conversational skills, peer entry skills, developing friendship networks, good sportsmanship, good host behavior during play dates, and handling teasing	-100% response rate - A 3-month follow-up by observation - No theoretical model	- Social skills	- Significant improvement in social skills	Moderate
Sofronoff et al., 2015/ Australia	PPI	N= 79 n = 38 parent and 41 children	including social problem solving skills. Behavioral components include the application of relaxation strategies called “relaxation gadgets,” role-plays, and parental reinforcement by supplying session rewards.	-100% response rate - 6 weeks of follow-up by self-report - No theoretical model	- Social skills and emotion management, self-efficacy, child anxiety	- Significant improvements in child social skills, self-efficacy, child behavior, and child anxiety levels	Weak
Radley et al.,	PPI	N= 2	Participants attended a 1-h	-100% response rate	- Social skills	- Improvements in	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
2016/ USA		children n = 2	social skills group each week over the course of approximately 11 weeks	- 6 weeks follow-up by observation - No theoretical model		social skills and social function	
Kim et al., 2008/ Korea	RCT	N= 15 children n = 8 C: n = 7	music therapy and play sessions with Toys	-100% response rate - A 3-month follow-up by observation - No theoretical model	- Joint attention behaviors and non-verbal social communication skills	- Effective at facilitating joint attention behaviors and non-verbal social communication skills	Moderate
Schertz et al., 2013/ USA	RCT	N= 23parent and children n = 11 C: n = 12	conducted weekly home-based intervention sessions with parents in their homes	-100% response rate - Immediate follow-up by observation - No theoretical model	- Joint attention	- Significant improvement in joint attention	Moderate
Sansosti and Powell-	PPI	N= 3 children	social stories were implemented, and conducted	-100% response rate - Immediate follow-up by	- Social behavior	- Significant improvement in social	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
Smith 2006/ USA		n = 3	three times per week	observation - No theoretical model		behavior	
Schreibman and Stahmer 2014/ USA	RCT	N= 39 children n = 19 C: n = 20	Communication (e.g., communication temptations), requirng a response from the child, and using direct reinforcement	-100% response - A 3-months follow-up by observation rate - No theoretical model	- Language skills	- Increament in language skills	Moderate
Mpella et al., 2019/ USA	PPI	N= 6 children n = 6	A theatrical play programme with the physical education regular school programme alongside. 16 educational sessions for eight weeks.	-100% response rate - Immediate follow-up by observation - No theoretical model	- Social Skill	- Enhancement of cooperation, attention, obedience, and empathy	Weak
Jonsson et al., 2019/ Sweden	RCT	N= 39 children n = 19 C: n = 20	an extended 24-week version of the social skills group training program KONTAKT with standard care	-100% response rate - 3 month follow-up by observation - No theoretical model	- Social skills	- Significant improvement in social skills	Moderate
Soorya et al.,	RCT	N= 69	A 12-session cognitive-	-49.3% response rate	- Social	- Significant	Strong

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
2015/ USA		children n = 35 C: n = 34	behavioral intervention (CBI) for verbal	- A 3-month follow-up by observation - Theory of Mind	Cognitive Skills	improvement in social behavior - No significant improvements in social cognitive outcomes	
Koning et al., 2013/ Canada	RCT	N= 15 children n = 7 C: n = 8	A 15-week CBT-based social skills intervention. During intervention, boys attended weekly 2 h long group sessions	-100% response rate - A 3-month follow-up by observation - Cognitive behavior theory	- Social perception, peer interaction, and social knowledge	- Significant improvements in social perception, peer interaction, and social knowledge	Moderate
Kruck et al., 2017/ France	PPI	N= 15 children n = 15	10 sessions of training programs with two therapists.	-100% response rate - Unknown follow-up by observation - No theoretical model	- Social and emotional skills	- Significant improvment in social and emotional skills following the training sessions	Weak
Parsons et	RCT	N= 60	The Therapeutic Outcome By	-98.3% response rate	- Visual motor,	- No significant	Strong

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
al., 2019/ Australia		children n = 30 C: n = 30	You (TOBY) application is delivered using a tablet device and can be accessed via the - Apple iTunes® store and received a 1-h training session provided by the researchers	- A 3-month follow-up by observation - No theoretical model	imitation, receptive language and social skills	between-group difference was recorded for visual motor, imitation, receptive language and social skills	
Mohammadzaheri et al., 2014/ Iran	RCT	N= 30 children n = 15 C: n = 15	Treatment sessions were conducted twice weekly for 60 min per session over a 3-month period.	-100% response rate - A 3-month follow-up by observation - No theoretical model	Communication skill	- Significantly effective in improving communication skill	Moderate
LaGasse 2015/ USA	PPI	N= 17 children n = 17	Children participated in ten 50-minute group sessions over a period of 5 weeks.	-100% response rate - A 3-week follow-up by observation - No theoretical model	Joint attention and communication skill	- Significant between-group differences for joint attention - No significant between-group differences for initiation of	Weak

Authors/ Country	Design	Participants	Intervention	Response percentage and duration of follow-up, theory and model used	Outcome measurement	Significant results	Study quality
						communication, response to communication skill	
Locke et al., 2018/ USA	RCT	N= 31 children n = 14 C: n = 17	School personnel were trained during the child's lunch recess (approximately 30–45 min) for 12 sessions over 6 weeks	-100% response rate - A 6-week follow-up by self-report - No theoretical model	- Social engagement	- Significantly higher social network inclusion and received more friendship nominations than children - Children in both groups experienced reduced solitary engagement and increased joint engagement	Moderate

Note: cPPI = controlled pretest/post-test interventions, PPI= pretest/post-test interventions, N= number, I = intervention group, C = control group or comparison group, RCT = randomized clinical trials

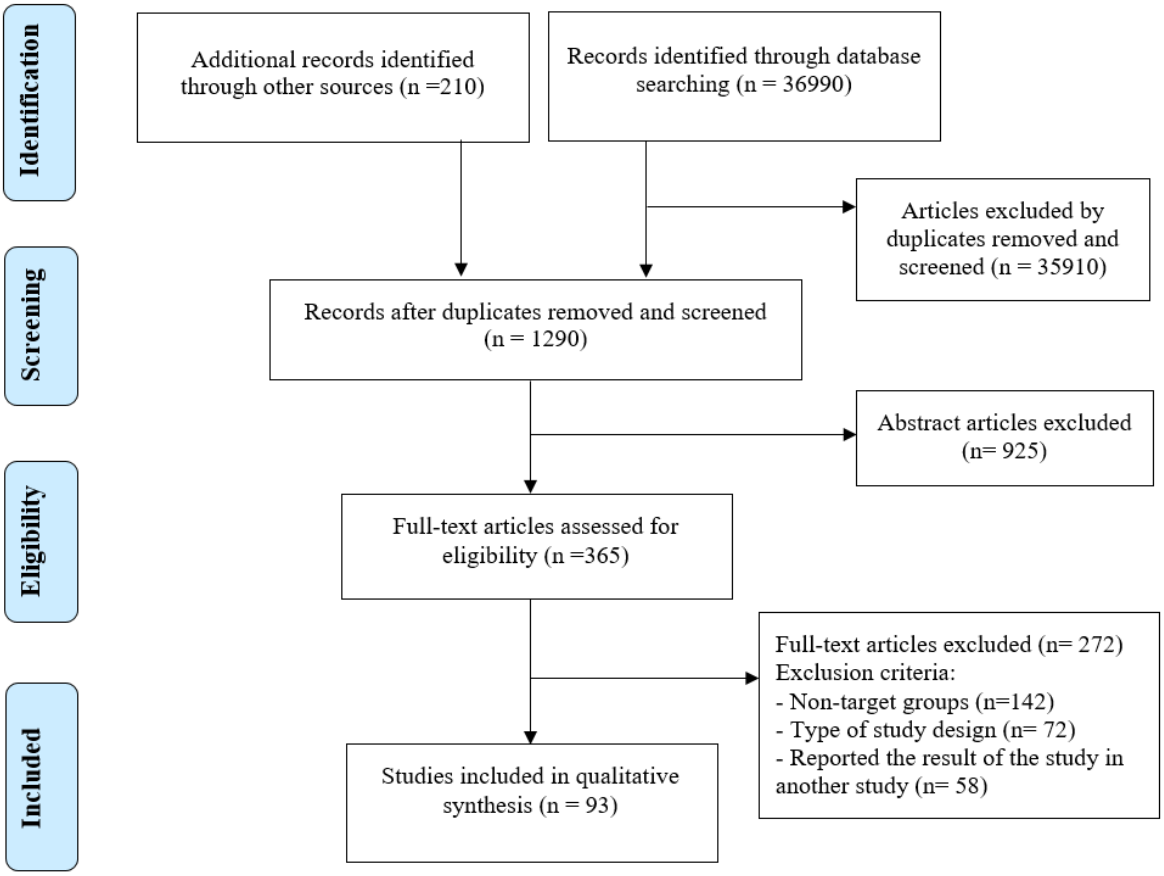

Fig. 1: Flow diagram for the identification, screening, eligibility and inclusion of studies

The majority of studies identified were randomized trials. Forty nine studies were randomized controlled interventions (15-63). Nine studies were controlled pretest/post-test interventions (64-72), thirty five studies were pretest/post-test interventions (73-107). In this line of studies, from 2009, seventy-nine other studies were also published (15-17, 19-24-26, 27, 29-32, 34-45,47-77, 79, 80, 83, 84, 88-94, 96, 98-102, 104-107), and fourteen studies were published from 1994 to 2009 (18, 25, 28, 33, 46, 78, 81, 82, 85-87, 95, 97, 103). Forty-one of the above mentioned studies were conducted in the USA (18, 19, 21, 23, 24, 30, 32, 34, 37, 38, 42-47, 49, 50, 53-56, 60, 61, 63, 74-79, 83-90, 94, 95, 97-100, 102, 107), seven in Australia (16, 36, 41, 52, 70, 92, 101), six in Canada (20, 35, 39, 40, 59, 62), three in France (17, 80, 96), three in UK (15, 25, 28), three in Netherlands (22, 57, 58), two in Japan (29, 82), two in Germany (81, 91), two in Iran (51, 64), two in Korea (33, 99), two in Sweden (48, 72), and one was conducted in India (65), Hong Kong (71), Taiwan (67), Nigeria (31), Switzerland (26), Spain (69), United Arab Emirates (27), Amman (68), Brazil (66), and Turkey (73). Most studies had a small sample size, so that the number of participants in thirty-five studies was less than 20 (17, 25, 27, 29, 33, 59, 62, 66, 69, 73-78, 80-86, 89-91, 93-96, 99, 100, 103-105, 107), and in thirty studies, it was between 20 to 50 (18, 19, 21, 24, 35, 38, 39, 42, 46, 48, 50, 51, 53, 55, 57, 61, 63, 64, 67, 68, 79, 88, 92, 97, 98, 102, 106). Follow-ups were often quite short; in 16 studies there were immediate follow-ups (46, 53, 66, 73, 75,

76, 84, 85, 89, 90, 93, 94, 99, 100, 103, 107); 30 studies had three months of follow up or less (15, 16, 21, 23, 24, 26, 32, 33, 35, 39, 40, 47, 48, 51, 52, 55, 57, 59, 61, 62, 65, 67, 70, 72, 74, 79, 83, 86, 98, 101, 102, 104, 105), and in 20 studies, it was more than three months (17-20, 22, 25, 28, 31, 36, 37, 41, 43, 44, 49, 54, 58, 60, 78, 80, 88, 91). In 27 studies, the follow-up duration was unknown (27, 29, 30, 34, 38, 42, 45, 50, 63, 64, 68, 69, 71, 76, 77, 81, 82, 84, 87, 89, 92, 94-97, 100, 106). Of the studies obtained, 20 studies focused on children and parents (20, 23, 25, 26, 29, 35, 37, 38, 41, 43, 53, 60, 63, 67, 87, 88, 94, 100, 101, 106), three studies focused on children and teachers (28, 30, 42), and the others on children with autism spectrum disorder.

Communication-focused interventions were used in twenty one studies (15, 21, 26, 31, 46, 50, 51, 54, 55, 66, 67, 75, 76, 82, 91, 93-95, 104). Thirty-two studies used integrative programs (18, 20, 24, 25, 28, 30, 33, 35-37, 40, 52, 58, 60, 62, 63, 71, 74, 77-79, 81, 86, 89, 92, 96, 98, 100-103, 107), and thirty studies used social skills development interventions (16, 17, 19, 22, 23, 29, 32, 34, 38, 39, 45, 47, 48, 56, 57, 59, 61, 64, 65, 69, 72, 73, 80, 83-85, 90, 97, 99, 105). Six studies included sensory motor interventions (42, 49, 53, 70, 87, 106). Two studies focused on contemporary Applied Behavior Analysis (ABA) interventions (41, 88). Two studies were based on Environmental modification programs (43, 44). As noted, most studies focused solely on integrative programs and social skills development interventions. The procedures included social stories, parent and child education programs, speech therapists and occupational therapists, small educational groups, home-based, and home visiting programs, solving social problems, using dolls, and holding workshops.

The results of the included studies were mainly based on observed data and only in fourteen studies, self-reports of the participants on their practices were used to evaluate the effects of interventions (23, 34, 40, 45, 58, 61, 64, 65, 70, 72, 77, 79, 100, 101). Of the included studies, only twelve (12.9%) used theories and models. Theory of Mind was the most frequent theoretical framework employed (19, 21, 39, 56-58, 64, 67). Other theories included behavioral cognitive theory (59), the DIR theory (87), social learning theory (105), and social motivation model (38). Theoretical frameworks in the studies were used only to guide the interventions' development.

Out of the 21 studies that were used for the communication-focused intervention approach, 16 studies significantly reached all expected outcomes. Five studies only examined the impact of the intervention on communication skills of the participants (46, 51, 54, 75, 76), three studies on language skills (27, 50, 55), two on collaborative interaction (67, 93), one study on emotional understanding (82), one study on emotion regulation (26), one study on communicative utterances (31), one study on communication symptoms (21), one study on expressive communication (94), and one study on communicative behaviors (95). But, four studies reported that some of the expected outcomes created significant differences (15, 68, 91, 104), and in one study, the intervention was not successful (66).

Out of the 32 studies that useimplemented integrative approach, 28 studies significantly reached all expected outcomes. Four studies only examined the impact of the intervention on communication and behavior skills of the participants (62, 92, 102, 107), four studies on emotional and social skills (71, 79, 96, 101), eight studies on social and communication skills (35, 30, 33, 35, 36, 81, 86, 100), three on social skills (18, 20, 89), three on emotional and communication skills (40, 77, 78), three on

social behavior skills (58, 60, 98), two on daily living skills (24, 37), and one study on social communication (103). But, two studies reported that the participants underwent significant changes in some of the expected outcomes (28, 63), and in two studies, the interventions were not successful in providing changes (52, 74).

Out of 30 studies on the social skills development intervention approach, 28 studies significantly reached all the expectd outcomes. 32 studies only examined the impact of the intervention on the social skills of the participants (16, 17, 22, 23, 29, 32, 34, 39, 47, 48, 59, 64, 65, 69, 72, 73, 80, 83-85, 90, 99, 105), three studies on behavior and social skills (45, 57, 97), one study on social motivation (38), and one study on social engagement (61). But, only two studies reported that some of the expected outcomes created significant changes (19, 56).

From among the six studies on the sensory-motor intervention approach, five studies significantly reached all expected outcomes. Only two studies examined the impact of the intervention on the joint attention of the participants (42, 53), one study on functional emotion (87), one study on social functioning (70), and one study on joint attention and joint engagement (49). But, one study reported that the participants significantly improved in some of the expected outcomes (106).

Two studies used contemporary applied behavior analysis approach in their interventions; one of them reported significant changes in some of the expected outcomes (41), and in the other one, the intervention was not successful (88).

Two studies applied environmental modification programs; both of them reachedin all expected outcomes. And both studies examined the impact of an intervention on environmental enrichment of the participants (43, 44).

We addressed the quality of randomized trials and non-randomized interventions (i.e. cPPI and PPI) separately. The majority of the RCTs (42/49) (15, 16, 18, 19, 21-30, 32-40, 42-51, 53, 55, 57, 63) were at moderate risk of bias. Six RCTs (17, 20, 31, 41, 52, 56) were classified as strong quality, and only one RCT (54) had a relatively high risk of bias and was classified as low quality. The majority of non-randomized intervention studies (42/ 44) (66-107) were assessed as having high risk of bias (low quality) and the remaining non-randomized trials were classified as moderate quality (64,65). None of these studies were classified as high-quality. The most general issues with quality were associated with confounders, data collection methods, and withdrawals.

Inter-rater agreement (Table 2) varied across EPHPP component ratings. For withdrawals and dropouts, there was a good agreement (0.636), and for other components, ratings were classified as having a very good agreement (k = 0.80 to 1.00).

Table-2: Inter-rater agreement for component ratings

Component ratings	Kappa value (SE)	P-value	Interpretation
Selection bias	0.816 (0.87)	0.001<	Very good agreement
Study design	1.000 (0.00)	0.001<	Very good agreement
Confounders	0.821 (0.73)	0.001<	Very good agreement
Blinding	1.000 (0.00)	0.001<	Very good agreement
Data collection methods	1.000 (0.00)	0.001<	Very good agreement
Withdrawals and drop-outs	0.636 (0.96)	0.001<	Good agreement

4- DISCUSSION

Although there are very limited numbers of review studies mentioned in the current systematic analysis, there has been no systematic review comprehensively examining the effectiveness of behavioral interventions to improve the primary symptoms associated with autism spectrum disorders in children. Thus, this study was conducted to eliminate the knowledge gap in this field. In the present review, eighty-three out of 93 studies were conducted in high-income countries. The majority of those studies were classified as having either low or medium quality. The majority of the studies were based on integrative programs designed to foster social skills development interventions. The results of the study showed that social skills development interventions were effective in achieving the desired outcomes. The results showed that regardless of the study design and the type of intervention used, the highest possibility of success in interventions was related to the participants' social skills.

Following article reviews conducted by the researchers, 93 studies were identified for evaluation in this systematic review. Fourty nine studies were randomized trial, and the rest were quasi-experimental. The sample size of most studies was small, and the follow-up durations of interventions were largely short or unclear. Also, the outcomes measured in the studies were mainly based on observation. The intervention approach used in 32 studies was integrative, and the majority could provide significant changes in all measures. Twelve studies used models and related theories, and 43 studies were poor in terms of quality. For these reasons, we can conclude that these studies provide no convincing evidence about the conducted interventions.

Most studies were designed as randomized trials. As also reported in a similar systematic review, most studies were conducted on behavioral interventions among children with autism spectrum disorder (2). If appropriately conducted, these studies can provide sufficient information in this area. Most studies were based on integrative and behavioral interventions and social skills development. These studies used a variety of strategies, and the results were in line with those of a study on behavioral interventions among children with autism spectrum disorder (2).

This review study displays that there are limited studies in this field in middle and low-income countries. Despite the fact that, fewer people live in high-income countries compared to middle- and low-income countries, the majority of studies were conducted in high-income countries; this may be due to better identification of children with autism spectrum disorder in those countries. Moreover, our study showed that, from among the eight RCT studies, seven were conducted in high-income countries, showing the importance of conducting such studies in low- and middle-income countries. However, since the majority of studies in high-income countries have been conducted by different types of research strategies, the evidence about studies of high-income countries is likely to be appropriate in low- and middle-income countries as well.

It is expected that the Integrated and combined interventions produce more positive outcomes than other interventions; though, the current review study revealed that such interventions, in achieving the targeted goals, were less successful compared to social skills development interventions. Interventions that work on only one construct in children with autism show better and more important outcomes than interventions that evaluate and assess multiple outcomes. Moreover, the results of these studies showed that few participants took part in most studies and

the length of the follow-ups were often short. Hence, studies with methodological weakness, few participants, and relatively short-term follow-up may not show the real effects of behavioral interventions on improving the primary symptoms associated with autism spectrum disorders.

Regardless of the study design and type of intervention used, our study showed that interventions have been successful in improving the skills of children with autism spectrum disorder, especially social skills such as play, conversational, emotional, and problem-solving skills. Therefore, this clarifies the need for effective interventions and follow-ups in children with autism spectrum disorders. The results of this review study indicated that the most effective behavioral treatments for ASD include interventions that address behavioral, social, and communicational deficits associated with the disorder.

The results of the current review revealed that the majority of studies did not explicitly use models and theories related to autism spectrum disorders. It is now clear that addressing social and behavioral science theories in designing a health plan could be related to the efficiency of the interventions. These frameworks help to recognize different skills and conditions (such as the cultural, economic, and social conditions) in which the behavior occurs.

Some of the mentioned studies in the current review had poor and moderate designs, and the majority of studies were classified as low quality. Almost half of the studies discussed in this review, were quasi-experimental, and other trial studies had some deficiencies in their methods and presentation of results. This in turn had a negative effect on the quality of the mentioned studies.

4-1. Limitations of the study

Several factors contributed to the limitations of this systematic review including using different study designs, including randomized controlled trials and quasi-experimental studies resulting in a variety of outcomes. These limitations lead to the impossibility of conducting a meta-analysis. We included multiple types of outcome measures and study designs which makes it impossible to perform the meta-analysis. Another limitation of this study could be a diffusion bias due to overlooking gray sources to evaluate the effectiveness of the interventions.

5- CONCLUSION

To increase the effectiveness of behavioral interventions for Autism Spectrum Disorders in Children, the following factors could be considered: application of randomized trial studies instead of quasi-experimental studies, increasing the duration of interventions and follow-ups, use of other intervention approaches, increasing sample size in studies for achieving the desired results, use of theory, models, and educational frameworks for creating novel pathways.

6- ETHICAL CONSIDERATIONS

The ethics code of Hamadan University of Medical Sciences was IR.UMSHA.REC.1398.287.

7- AVAILABILITY OF DATA AND MATERIAL

All data generated or analyzed during this study are included in this published article.

8- COMPETING INTERESTS

The authors declare that they have no competing interests.

9- FUNDING

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10- AUTHORS' CONTRIBUTIONS

All authors read and approved the final manuscript. SB, MA, EJ and AM conceived of the study and participated in the design, data collection and analysis as well as preparation. MA, EJ and AM participated in the data analysis and preparation. MA participated in data collection.

11- ACKNOWLEDGMENTS

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APPENDIX A

Pervasive Child Development Disorder* or Kanner* or Speech Disorder* or Communication Disorder* or Autis* or Asperger or PDD or PDD-NOS or Childhood Disintegrative Disorder* or Childhood Schizophrenia) and Behavior Therapy or Social Skills Training or Applied Behavioral Analy (ABA)* or Intensive Behavioral Intervent (IBI or IBT)* or applied verbal behavior or verbal behavio* or (verbal NEAR (therap* or communicat*)) or lovaas or linwood or Douglass or CABAS or DTT or (Treatment NEAR Education NEAR Autistic NEAR communication NEAR Handicapped NEAR children) or teacch or floor time or "Social Communication Emotional Regulation Transactional Support" or scerts or (pivotal NEAR response) or discrete trial* or (((sensory or auditory) or (treat* or therap*)) or Sensory Motor Integration or facilitated communication or Family Therapy or ((parent or parents or caregiver* or care-giver* or family or families or mother* or father* or maternal* or paternal*) NEAR (treat* or therap* or interven* or direct* or program* or train* or mediat* or rehabilit*)) or Picture Exchange or Sensory stimulation or Language Therapy or Speech Therapy or (Alternative NEAR Augmentative NEAR Communication) or occupational therapy or Computer-Assisted Instruction or (assist* NEAR tech*) or Dance Therapy or Music Therapy or Play Therapy or Socio environmental therapy or Early Intervention or (computer NEAR (teach* or instruct*)) or social stories or prompt* or ((augment* or social) NEAR communicat*) or (relationship NEAR develop*) or (cognitive(or (treat* or therap* or psychotherap*)) or cbt or (sound NEAR (treat* or therap*)) or (natural NEAR environment) or (activity NEAR schedule*) or (direct NEAR instruct*) or (giant NEAR step*) or developmental individual difference or option or (sonrise or kaufman) or precision or (social NEAR skill*) or hanen or miller or patterning* or philadelphia or (dolman or delaccato) or (echange NEAR developpement) or bartelemy or (gentle NEAR teach*) or denver or leap or (learning experiences NEAR alternative program) or pcdi or “princeton child development institute” or rutgers or (natural NEAR teach*) or milieu or (neurodevelop* NEAR treat*) or ndt or walden or adlerian or theraplay or Eden or (social NEAR pragmatic) or "early bird" or (video NEAR model*) or (self NEAR (manage* or monitor*)) or yale or bancroft or horizon or “may institute”)

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