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Application of intervention strategies for behavior management in autism spectrum disorder in childhood and adolescence. a systematic review

Aplicación de estrategias en intervención para el manejo de la conducta en el trastorno del espectro autista en infancia y adolescencia. una revisión sistemática

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Abstract. Introduction and objectives: autism spectrum disorder (ASD) is a neurodevelopmental disorder, which exhibits symptoms such as early-onset impairment of interaction and social communication, as well as repetitive and restricted sensory and motor behavior. This study aims to carry out a systematic review regarding the application of intervention strategies for behavior management in autism spectrum disorder in childhood and adolescence. Methods: A systematic search of Randomized Controlled Clinical Trials conducted between January 2016 and June 2021 found in PubMed, Scient direct y Scopus was performed. Keywords used were "Psychomotor, disorder, autism, behavior, intervention". Results: 2 845 records were found, and, after further analysis, 45 articles were obtained for the final analysis, with a number of participants (n=3 439), age range: 8-17 years of age, confirmed diagnosis of autism spectrum disorder. As a result, we found The use of technological resources is associated with a significant reduction in clinical severity of ASD, functioning global assessment, and social manifestations of anxiety. Conclusions: the authors to conclude that there are several strategies used for behavior management in autism spectrum disorder, the use of technological tools stands as a promising option as they are highly beneficial and contribute to achieve behavioral therapeutic objectives.
Keywords: Psychomotor, disorder, autism, behavior, intervention.

Resumen. Introducción y objetivos: el trastorno del espectro autista (TEA) es un trastorno del neurodesarrollo, que presenta síntomas como deterioro temprano de la interacción y la comunicación social, así como conducta sensorial y motora repetitiva y restringida. Este estudio tiene como objetivo realizar una revisión sistemática sobre la aplicación de estrategias de intervención para el manejo de la conducta en el trastorno del espectro autista en la infancia y la adolescencia. Métodos: Se realizó una búsqueda sistemática de Ensayos Clínicos Controlados Aleatorizados realizados entre enero de 2016 y junio de 2021 en PubMed, Scient direct y Scopus. Las palabras clave utilizadas fueron "Psicomotricidad, trastorno, autismo, conducta, intervención". Resultados: se encontraron 2 845 registros y, luego de un análisis más profundo, se obtuvieron 45 artículos para el análisis final, con un número de participantes (n=3 439), rango de edad: 8-17 años, diagnóstico confirmado del espectro autista. trastorno. Como resultado encontramos que el uso de recursos tecnológicos se asocia con una reducción significativa de la gravedad clínica del TEA, evaluación global del funcionamiento y manifestaciones sociales de la ansiedad. Conclusiones: los autores concluyen que existen varias estrategias utilizadas para el manejo de la conducta en el trastorno del espectro autista, el uso de herramientas tecnológicas se erige como una opción prometedora ya que son altamente beneficiosas y contribuyen a lograr los objetivos terapéuticos conductuales.
Palabras clave: psicomotricidad, trastorno, autismo, conducta, intervención.

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Introduction

According to Diagnostic and Statistical Manual of Mental Disorders (DSM-5, 2013) and, International Classification of Diseases (ICD-11, 2018), Autism spectrum disorder (ASD) is a neurodevelopmental disorder, which exhibits symptoms such as early-onset impairment of interaction and social communication, as well as repetitive and restricted sensory and motor behaviors (Lord et al., 2018) Prevalence of ASD is increasing, due to recent changes in diagnostic criteria and optimization of assessment instruments, which are specific for this population (Mariño et al., 2021).

Considering the severity levels of ASD clinical symptoms, efforts are currently focused on research into intervention strategies that make it possible to mitigate the severity of symptoms and difficulties associated with diagnosis (Zwaigenbaum et al., 2015; Lai et al., 2020). There is evidence based on studies that evaluate the effectiveness of interventions ranging from conventional (Murza et al., 2016) to the use of virtual reality-based intervention modalities, application of alternative methods and the inclusion of parental involvement in treatment, (Gerow et al., 2018) all of these, designed with the purpose of reducing behavioral problems and stimulating the development of social, communicative, sensory, and motor skills (Marave et al., 2021).

This study aims to carry out a systematic review regarding the application of intervention strategies for behavior management in autism spectrum disorder in childhood and adolescence. A systematic search of Randomized Controlled Clinical Trials conducted between January 2016 and June 2021 found in PubMed, Scient direct y Scopus was performed following PRISMA systematic review and meta-analysis recommendations.

Methods

Inclusion criteria

Review of randomized controlled clinical trials conducted between January 2016 to June 2021, without language limits, related to intervention strategies for behavior management in autism spectrum disorder during childhood and adolescence, following PRISMA systematic re-

view and meta-analysis recommendations (Urrútia, 2010). The following PICO question (population, intervention, comparison, outcome) was formulated: What intervention strategies are used for behavior management in autism spectrum disorder in childhood and adolescence?

Search strategy

A systematic search of randomized controlled clinical trials conducted between January 2016 and June 2021 in PubMed, Scient direct y Scopus was performed. Keywords used were "psychomotor, disorder, autism, behavior, intervention", using with five search criteria, through corresponding Boolean operators "OR" and "AND" and source-specific search filters. Authors conducted the searches in 3 phases: The initial search provided a total of 2 845 articles. In a first phase of analysis, it was determined that 652 met eligibility criteria, 134 were excluded due to duplication. During the second phase, 140 articles were selected for complete reading. In the third phase, evaluation of methodological quality, level of evidence and grade of recommendation were performed. After this selection process, 45 manuscripts were included for the final analysis (Figure 1).

Selection criteria

Only randomized controlled trials (RCT), published in the last 5 years were included, methodological quality was evaluated using the PEDro scale (https://www.pedro.org.au) with a minimum score of 6 and level of evidence "I", grade of recommendation "A" using the classification proposed by the Centre for Evidence-Based Medicine of Oxford (CEBM), without language limitations (Table 1).

Characteristics of participants and interventions

Participants should be within age ranges of childhood and adolescence, and present a diagnosis of autism spectrum disorder, without restrictions of gender, type or severity. Experimental group should be exposed to a treatment, which included strategies for behavior management. Control groups should receive a different modality of intervention or no treatment at all. In this study, papers without control group were excluded.

Analysis and data extraction

The manuscripts included were analyzed for: 1) characteristics of studied population: number of participants, diagnosis and age; 2) characteristics of interventions: design, frequency, duration, co-intervention and control group (Table 2). 3) characteristics of outcome measures of primary and secondary variables (Table 3). The aforementioned data were obtained by using the CONSORT statement for RCT (Schulz, et al., 2010) whenever possible.

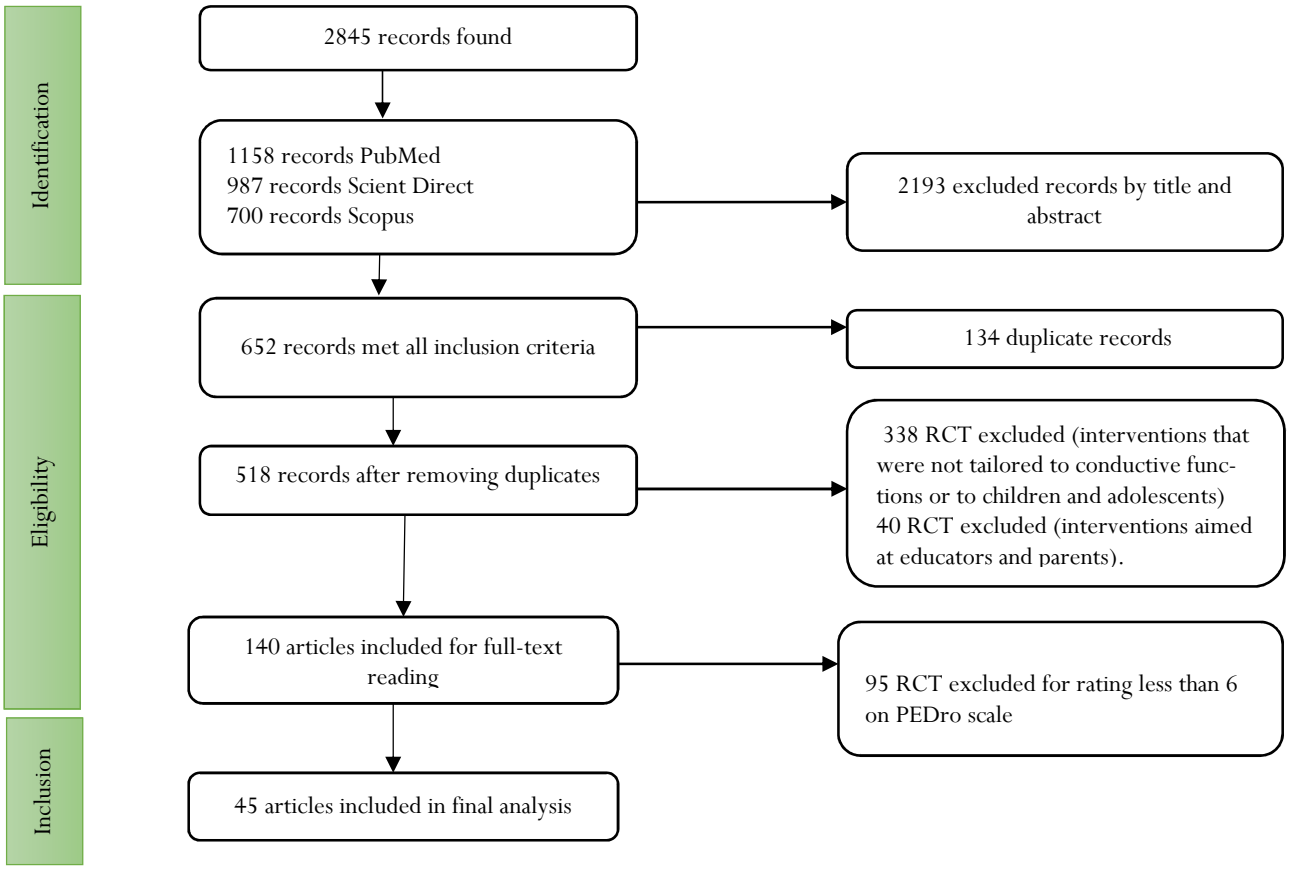

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Figure 1. *Study algorithm*

Table 1.
Score of the studies included in the scale PEDro and classification according to Centre for Evidence-Based Medicine de Oxford (CEBM)

	PEDro												CEBM	
Author	1	2	3	4	5	6	7	8	9	10	11	Total	level of evidence	grade of recommendation
McKinney et al. (2020)	SI	1	1	1	0	1	0	1	1	1	1	8	1B	A
Peña et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Sarabzadeh et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Kashefimehr et al. (2018)	SI	1	1	1	0	0	1	1	1	1	1	8	1B	A
ElGarhy & Liu (2016)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Pan et al. (2017)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Trubanova et al. (2020)	SI	0	0	1	0	0	0	1	1	1	1	5	1B	A
Hill1 et al. (2020)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Tse (2020)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Rabeyron (2020)	SI	1	1	1	0	0	1	1	1	1	1	8	1B	A
Wood et al. (2020)	SI	1	1	1	0	1	1	1	1	1	1	9	1B	A
Hadoush et al. (2020)	SI	1	0	1	0	0	1	1	1	1	1	7	1B	A
Jin et al. (2020)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Mills et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Hawkins et al. (2019)	SI	1	1	1	1	1	1	1	1	1	1	10	1B	A
Phung & Goldberg (2019)	SI	1	0	1	1	1	1	1	1	1	1	9	1B	A
Nowell et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Marro et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Gamez et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Albaum et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Voss et al. (2019)	SI	1	1	1	0	1	1	1	1	1	1	9	1B	A
Maskey et al. (2019)	SI	1	1	1	0	1	1	1	1	1	1	9	1B	A
Wang et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Germone et al. (2019)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Parsons et al. (2018)	SI	1	0	1	0	0	1	1	1	1	1	7	1B	A
Tse et al. (2019)	SI	1	0	1	0	0	1	1	1	1	1	7	1B	A
Riquelme et al. (2018)	SI	1	0	1	0	0	0	1	1	1	1	6	1B	A
Sharda et al. (2018)	SI	1	0	1	0	0	1	1	1	1	1	7	1B	A
Padmanabha et al. (2019)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Dekker et al. (2019)	SI	1	1	1	0	0	0	1	1	1	1	7	1B	A
Morgan et al. (2018)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Chang et al. (2018)	SI	1	1	1	1	1	1	1	1	1	1	10	1B	A
Weiss et al. (2018)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Yu et al. (2018)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
So et al. (2018)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Toscano et al. (2018)	SI	1	1	1	0	0	0	1	1	1	1	7	1B	A
Crawford et al. (2017)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Bieleninik et al. (2017)	SI	1	1	1	0	0	0	1	1	1	1	7	1B	A
Olsson et al. (2017)	SI	1	1	1	0	0	0	1	1	1	1	7	1B	A
Sotoodeh et al. (2017)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Yun et al. (2017)	SI	1	1	1	0	0	1	1	1	1	1	7	1B	A
Conaughton et al. (2017)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Touzet et al. (2017)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Petty et al. (2017)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A
Porter et al. (2017)	SI	1	1	0	0	0	0	1	1	1	1	6	1B	A

The selection criteria were specified. 2. Subjects were randomly assigned to groups (in a crossover study, subjects were randomized as they received treatments). 3. Allocation was concealed. 4. The groups were similar at the beginning in relation to the indicators of most important forecast. 5 All subjects were blinded

6. All therapists who administered the therapy were blinded. 7. All raters who measured at least one key outcome were blinded. 8. Measures of at least one of the key outcomes were obtained from more than 85% of the subjects initially assigned to the groups. 9. Results were presented for all subjects who received treatment or were allocated to the control group, or where this could not be, data for at least one key outcome were analyzed by "intention to treat" 10. Results of statistical comparisons between groups were reported for at least one key outcome. 11. The study provides point and variability measures for at least one key outcome.

Table 2
Characteristics of included studies

Author	Objective	Participants	Experimental group	Control group
McKinney et al. (2020)	To determine the clinical efficacy of Point OutWords in improving interaction in verbal or non-verbal children	46 children with autism spectrum Age range: 3 to 15 years with diagnosis (ADOS-G)	N=23 Training with Point OurWord. Half an hour, five times a week, for 8 weeks	N=23 iPad clinical therapy training using apps, plus standard intervention
Peña et al. (2020)	To compare motor performance between youth with ASD and a typically developing control group with Kinect	50 children. Age Range: 7 to 15 years old with mild and moderate ASD belonging to the Interated Psycho-Pedagoical Support Group (GAPI)	N=25 (TEA) Training with Kinect (non-contact) and in keyboard environments (with contact) 5 trials of 20 minutes	N= 25 (Typical Development) Training in Kinect-based synchronization tasks (without contact).
Sarabzadeh et al. (2019)	To investigate the effectiveness of Tai Chi Chuan in improving motor function in children with ASD	18 children with ASD. Age range: 6 to 12 years old. Autism Rating Scale (GARS2)	N= 9 (TEA) 18 sessions of 60 (10 minutes warm-up, 40 basic forms of Tai Chi chuan and 10 cool-down).	N= 9 (TEA) Did not receive intervention
Kashefimehr et al. (2018)	To examine the effect of sensory integration therapy (SIT) on occupational performance in ASD children	31 children with ASD. Age range: 3 to 8 years diagnosed with Diagnostic and Statistical Manual of Mental Disorders V	N= 16 (TEA) 24 sessions of SIT plus occupational therapy, each 45 minutes, using sensory activities	N= 15 (TEA) 24 sessions of occupational therapy, each lasting 45 minutes
ElGarhy & Liu (2016)	To examine the effects of a psychomotor intervention program (PIP) for (TEA)	28 children with ASD. Age range: 3-7 years old. Assessment of basic language and learning activities	N= 14 (TEA) trained with PI (concepts of body, time and space) 3 times a week for 10 weeks	N= 14 (TEA). Regular educational program, without PI
Pan et al. (2017)	To examine the effects of a physical activity intervention on motor skills and executive function in children with (ASD)	22 children with ASD, Age range: 3 to 8 years diagnosed with Diagnostic and Statistical Manual of Mental Disorders IV, level 3.	N= 11 (TEA) Physical activity program, 90-minute sessions, with warm-up, motor-cognitive skills training and cool-down	N= 11 (TEA) Regular physical therapy intervention program
Trubanova et al., (2019)	Ability to recognize facial expressions and emotions in children with and without ASD.	40 children. Age range: 9-12 years old. Diagnosed with Wechsler Intelligence Scale and ADOS-2	N= 20 (TEA) each child participated in a Microsoft Kinect technology FEET session to capture facial features	N= 20 (Typical development) each child participated in a FEET session using Microsoft Kinect technology to capture facial features
Hill1 et al. (2020)	To explore the impact of including a dog in occupational therapy sessions on task behaviors	22 children. Age range: 9-12 years old Diagnosis of ASD according to DSM-V. ADOS-2	N= 11 (TEA) Received seven one-hour sessions with animal-assisted therapy	N= 11 (TEA). They received seven sessions of conventional occupational therapy without the assistance of dogs
Tse1 (2020)	Effect of physical exercise on emotional and behavioral regulation in ASD.	27 children. Age range: 8-12 years old. Diagnosis of ASD (DSM-5), Wechsler Scale	N= 15 (TEA) Jogging program 48 sessions (4 sessions per week; 30 minutes per session for 12 weeks)	N=12 (TEA). without intervention
Rabeyron (2020)	To assess the efficacy of music therapy on autistic symptoms in children	37 children. Age range: 4-7 years old. Psychiatric tests were performed with: Scale (CARS), (ABC,) (CGI-I)	N= 18 (TEA). 25 sessions of 30 minutes for 8 months, with a therapist and cotherapist with training in music therapy	N= 18 (TEA) The sessions lasted, in the same room, using only commercial music.
Wood et al. (2020)	To compare 2 programs of cognitive behavioral therapy (CBT) and conventional treatment (CT)	148 children. Age range: 7-13 years old. With a diagnosis of ASD, IQ of 70 or more points (± SEM) and Anxiety Scale of ≥14.	N= 71 (TEA) (Behavioral Interventions for Anxiety in Children with Autism Group). 16 sessions of 90 minutes (children and parents)	N= 77 (TEA) (Coping Cat Group). Participants received 16 weekly 60-minute sessions of conventional therapy
Hadoush et al. (2020)	Effect of bilateral anodal transcranial current stimulation applied to left and right prefrontal and motor areas in ASD	50 children with ASD. Age range: Between 4 - 14 years Diagnosed with ASD. Childhood Autism Rating Scale (CARS) and Checklist Scale (ATEC)	N=25 (TEA) 10 sessions (20 minutes, five per week) of bilateral anodal stimulation applied simultaneously on left and right motor and prefrontal areas	N=25 (TEA) Same intervention with simulated bilateral anodal stimulation, applied simultaneously on left and right motor and prefrontal areas
Jin et al. (2020)	To compare the clinical effect on attention and social communication in ASD.	60 children. Age Range: 9-13. For ASD diagnosis verification (ATEC) and (ABC) were used	N=30. Catgut embedding therapy was applied to Shenting 24) at scalp acupuncture point 1 time for 4 weeks.	N= 30 (TEA) Conventional therapy with behavioral education, speech training and music therapy
Whitney et al. (2019)	Explore effects of hydrotherapy on emotional behaviors	8 children. Age range: 6-12 years old. Diagnosed with ASD	N= 4 (TEA) Hydrotherapy 4 weeks. The sessions lasted 45 minutes and were planned once a week	N= 4 (TEA) Without hydrotherapy
Hawkins et al. (2019)	Evaluate the effects of aromatherapy on anxiety induced in ASD	28 children Age range: 6-11 years. Any type of ASD was accepted in the study.	N= 14 (TEA). 5 drops of bergamot essential oil were administered by inhalation for 15 minutes	N= 14 (TEA) Placebo with the same administration criteria as the experimental group
Phung & Goldberg (2019)	Evaluate a mixed martial arts intervention in the improvement of executive functions (EF) in (TEA).	34 children. Age range: 8-11 years old. Participants had ASD Social Communication Questionnaire (SCQ)) and (ADOS-2)	N= 14 (TEA). Program of 26 classes over a period of 13 weeks, with a duration of 45 minutes	N= 20 (TEA) Did not participate in the martial arts program
Nowell et al. (2019)	To examine a parent-assisted intervention that combines components of TEACCHing and social thinking.	15 children Age range: 6-8 years old. Medical diagnosis of ASD by (ADOS)	N= 7. GoriLLA groups met 90 minutes a week, in parent work sessions of 20 to 30 minutes	N=8 Same intervention without prior exposure to these courses

Marro et al. (2019)	To explore a social performance-based intervention for the explicit social knowledge in ASD	69 children. Age range: 12-13 years (SCQ; (ADOS-2; and confirmation of IQ>70, Kaufman's brief test. (KBIT-2)	N= 56 (TEA) participated in groups of 1.5 hours per week for 10 weeks. The, socio-dramatic affective-relational intervention (SDARI).	N= 13 The intervention was carried out 5 hours a day, 5 days a week for 6 weeks, for a total of 29 days
Gamez et al. (2019)	To investigate limb coordination in children with ASD	12 children Age range: 7-12 years. With certified high-performance TEA	N=6. Performed 30 repetitions of an upper extremity fitts law objective reciprocal task by flexing and extending their right arm	N= 6 performed 15 repetitions of an upper extremity fitts law target reciprocal task by flexing and extending their right arm
Albaum et al. (2019)	To determine the early and late alliance variables in cognitive-behavioral therapy aimed at emotion regulation for ASD	48 children Age range: 8-12 years with average intellectual functioning (INTELLECTUAL COEFFICIENT ⩾ 79) Abbreviated Wechsler Intelligence Scale (SCQ).	. N= 24 (TEA) 10 individual therapy sessions attended by therapist, child, and primary caregiver with early therapeutic alliance	N= 24 (TEA) 10 individual therapy sessions attended by therapist, child, and primary caregiver with late therapeutic alliance
Voss et al. (2019)	Efficacy of Superpower Glass, an AI-driven wearable behavioral intervention for social outcomes in ASD.	71 children with ASD. Age range: 6 to 12 years with a formal diagnosis of ASD	N= 40 (TEA) Superpower Glass intervention, on Google and a smartphone application, for facial expressions, with 20-minute sessions at home, 4 times, per week for 6 weeks	N= 31 (TEA) Conventional treatment with ABBA. Applied Behavior Analysis
Maskey et al. (2019)	To examine the feasibility and acceptability of an immersive virtual reality environment (VRE) in conjunction with cognitive behavioral therapy (CBT) for ASD with specific phobia.	32 children. Age range: 8-14 years old with a diagnosis of ASD and the. (ADIS).	N= 16 (TEA) Each participant and parent attended a 45-minute session with their assigned therapist. Simplified CBT techniques were introduced, including identifying thoughts, emotions, and behaviors).	N= 16 (TEA) Same intervention without follow-up at two weeks and at 6 months
Wang et al. (2019)	To study the clinical efficacy of interactive group sandplay versus individual sandplay in the treatment of preschool children with (ASD)	80 children. Age range: 4-6 years old. Diagnosed with ASD according to (DSM-5)	N=40 (TEA) Adopted the group sand tray intervention method: 1 time per week, 50 min each time, a total of 12 test cycles.	N=40 (TEA). Individual sandbag interventions: 1 time per week, 50 min each time, a total of 12 test cycles.
Germone et al. (2019)	To investigate the benefits of animal-assisted activities with dogs and psychiatrically hospitalized youth with ASD	67 children. Age range: 6-12 years old. Diagnosis of ASD confirmed with (ADOS-2).	N= 31 (TEA) Classroom located in the hospital unit, consisted of two to four participants, followed a sequence with 5 minutes of play. followed by a social skills group with an average duration of 17 minutes.	N= 36 (TEA) Classroom located in the hospital unit, consisted of two to four participants, followed a sequence with 5 minutes of play. followed by a social skills group with an average duration of 17 minutes.
Parsons et al. (2019)	Improving visual motor, imitation, language, and social skills in young children with ASD	60 children. Age range: 2-6 years old. Diagnosed with ASD according to the Manual (DSM-V)	N=30. They practiced 20 minutes on the TOBY app daily for 3 months using an iPad. Participants were then reassessed at 3 and 6 months.	N= 30 the control group received the TOBY app for 3 months.
Tse et al. (2019)	To examine the impact of physical activity on sleep quality and cognition in children with autism spectrum disorder	40 children. Age range: 8-12 years Diagnosis of ASD, (DSM-5)	N= 20.12 weeks of 24-session intervention (two sessions per week; 45 min) Warm-up (10 min), basketball (30 min), and cool-down (5 min).	N= 20. Normal daily routine without participating in any physical activity program.
Riquelme et al. (2018)	To explore the influence of somatosensory therapy on somatic sensory parameters in ASD	59 children. Age range: 4-15 years old. Diagnosis of ASD according to the criteria (DMS)	N= 30 (TEA) 2 weekly sessions of 45 minutes, in group sessions of 6 to 8 participants for 8 weeks.	N= 29 (TEA) 2 weekly sessions of 45 minutes, in group sessions of 6 to 8 participants for 8 weeks.
Sharda et al. (2018)	To assess the neurobehavioral outcomes of an intervention with and without music on social communication and brain connectivity in school-age children.	51 children. Age: 6-12 years old. TORCH. ADOS, (SRS-II), (CCC-2) Vineland scale (VABS-MB) Quality of life. (CFoL).	N=26 (TEA) included improvisational approaches through song and rhythm in individual weekly 45-minute sessions conducted over 8-12 weeks with a licensed music therapist	N= 25. Structurally matched behavioral intervention implemented in a non-musical context.
Padmanabha et al. (2019)	To determine the feasibility and efficacy of home sensory interventions in children with autism spectrum disorder (ASD)	40 children. Age range: 3-12 years old. Diagnosed as ASD according to (DSM-V)	N= 21. Speech therapy, applied behavior analysis provided by a child psychologist.	N= 19 Did not receive intervention
Dekker et al. (2019)	Immediate and long-term effect of parent-teacher engagement on social skills in the daily lives of children with ASD compared to SST (group training)	112 children. Age range: 9-13 years old. With clinical diagnosis of ASD, according to DSM-IV.	N= 45. The training consisted of 15 basic weekly 90-minute group sessions and three additional 90-minute booster group sessions.	N= 45. Parents participated in three group sessions before and five during group training (SST) in the company of teachers
Morgan et al. (2018)	To assess the efficacy of the intervention (CSI, by sessions) in the classroom social, communication, emotional regulation and transactional support (SCERTS, compared to school education	60 children. Age range: 6-11 years old. With a diagnosis, either clinical or educational, of ASD or Asperger's Syndrome as defined by DSM-IV.	N= 34 (TEA) The intervention consisted of an 8-month (school year) trial of the application of this model to each student's classroom	N= 26 (ASD) Received regular school education with autism training modules for teachers.

Chang et al. (2018)	To examine play skills in differential contexts (structured play assessment versus intervention play sessions) after a JASPER intervention.	58 children. Age range: 5-8 years old. Diagnosis of ASD confirmed by (ADOS; linguistic abilities with Peabody Picture Vocabulary)	N= 29. Joint attention, symbolic play and social language during children's preferred play activities (JASPER) and systematic stimulation of spoken language. For 1 hour, 2 times a week for 3 months.	N= 29. The intervention consisted of intensifying the sessions at 3 and 6 months of JASPER treatment (joint attention, participation in symbolic play and regulation) + TMS (Enhanced Environment Teaching.
Weiss et al. (2018)	To examine the efficacy of a behavioral behavioral therapy intervention to improve emotional regulation in ASD.	68 children. Age: 8-12 years old. with diagnosis of ASD (SCQ >14;) (SRS-2 Total T-Score cutoff >59; confirmation of ASD by ADOS.	N= 35. 10 sessions of emotion regulation activities Sessions included education, in vivo practice of skills, planning.	N= 33. 10 sessions of conventional behavioral conductive treatment, once a week.
Yu et al. (2018)	To test the effectiveness of a supervised game-based exercise training program for motor skills and physical fitness.	112 children. Age range: 4 to 6 years old. With a formal diagnosis of autism, diagnostic and statistical mental disorder (DSM-IV)	N= 56 Game-based exercise training program, with 2 sessions per week, of 1 hour. for 16 weeks.	N= 56 Game-based exercise training program, with 2 sessions per week, of 1 hour for 16 weeks
Chee So et al. (2018)	Evaluate the level of gestural production of children with ASD and determine an increase in verbal imitation after robot training	45 children. Age range: 4-6 years old. Diagnosis ASD, (ADOS) and Diagnosis Interview-Revised (ADlR)	N= 30 (TEA) The intervention program was 9, with two sessions of 30 minutes, twice a week.	N= 15 (Typical Development) Imitation of gestures with educational videos with the same dosage as the experimental group
Toscano (2018)	To examine the effects of an exercise-based intervention on metabolic profile, autism traits and perceived quality of life in children with (ASD)	64 children with ASD. Age range: 6 to 12 years old. With a diagnosis of ASD according to DSM-IV.	N= 46 (TEA) 48-week physical activity program, based on coordination and strength exercises with 40-minute sessions twice a week.	N= 18 (TEA). They received conventional care for ASD populations. No exercise sessions
Crawford et al. (2017)	To examine the effects of improvisational music therapy (IMT) on social affect and responsiveness in ASD.	364 children. Age range: 4 and 7 years old ASD diagnosis with the ADOS	N= 182. It involved two treatment groups in music therapy sessions at two different levels of frequency: 1 time per week (low frequency) or 3 times per week (high frequency).	N= 182. Counseling, support for parents (three sessions) and usual care
Bieleninik et al. (2017)	To examine the effects of improvisational music therapy (IMT) on social communication skills of children with ASD	364 children. Age range: 4-7 years old. Who met the criteria for ASD according to (ADOS)	N= 182 Improvised music therapy was offered in outpatient settings in individual 30-minute sessions (possibly accompanied by family members).	N= 182. It consisted of in-clinic care, plus three 60-minute counseling sessions for parents.
Choque et al. (2017)	Assess the effect of social skills training on ASD	296 children and adolescents. Age range: 8-17 years old. diagnosis by (ADOS). Wechsler scale.	N= 15. Social skills training (SSGT), for 12 weeks, twice a week (6 minutes for children) and (90 minutes for adolescents).	N= 146 Conventional therapies with physiotherapy, neurology, occupational and speech therapy
Sotoodeh et al. (2017)	To examine the effect of yoga training program (YTP) on the severity of ASD	29 children. Age range: 7 to 15 years old DSM-5 Diagnosis. diagnosis of ASD by (ADI-R)	N= 15. They received an 8-week Yoga Training Program (YTP) (24 sessions) for 30 minutes.	N= 14. They did not receive Yoga treatment, only work on activities of daily living.
Yun et al. (2017)	To assess behavioral interventions that used a robot as a facilitator for children with ASD	15 children. Age range: 4-7 years with ASD and verbal IQ of less than 60	N= 8 Robot intervention program 8 teaching protocol sessions and 2 social skills: eye contact and recognition of facial emotions	N= 7. A human therapist facilitated the intervention
Conaughton et al. (2017)	To assess the efficacy of BRAVE-ONLINE (online training in behavioral therapy for anxiety)	42 children. Age range: 8 to 12 years old and anxiety disorders for DSM-IV	N= 21. 10 sessions for children and six for parents, each lasting 60 minutes, completed weekly online, plus 2 reinforcement sessions held at 1 and 3 months.	N= 21. Participants and assigning parents on waiting list
Touzet et al. (2017)	Evaluate the effectiveness of 12 hours a week with the Denver intervention model at the cognitive level in ASD from 15 to 36 months	180 children. Age range: 15-16 months. Diagnosis of ASD (DSM-5); (ADOS-2), (ADI-R).	N=60 Received 12 hours per week of ESDM by trained therapists, 10 in the center and 2 in the natural setting (alternately by therapist and parent)	N= 120 They received interventions such as speech therapy, occupational therapy, as well as individual or group psychotherapy.
Petty et al. (2017)	To examine the effects of a randomized therapeutic riding intervention (THR) trial	67 children. Age range: 6 to 16 years old Diagnosis of ASD or Asperger's	N= 31 Received 10-week Therapeutic Riding Intervention (THR)	N= 36. They did not receive horse riding.
Sam Porter et al. (2017)	To examine the efficacy of MT (Music Therapy) in clinical practice	N= 251 children. Age range: 8-16 years old	N= 123 Received 12 weekly sessions of TM plus usual care, with follow-up at 13 weeks.	N= 128. Received usual therapeutic care

Table 3.
Variables, scales, and main results of the included studies

Author	Variables	Outcome measures	Results
McKinney et al. (2020)	Sensory perception, cognitive and motor control and motivation Motor control and sequencing	SRS-2, BPVS-III, DCMA y BOSCC MSEL y VMPAC	Point OurWords training improves motor sequences and problems of cognition and social communication. with a recruitment rate of 62.8% within a 95% confidence interval of ±14%.
Peña et al. (2019)	Motor learning cognitive and motor skills	IQ, CARS	The regression analysis did not show any significance. This result means that IQ and CARS scores did not have an influence on the improvement in performance P = 0.096, r 2 = 0.38).
Sarabzadeh et al. (2019)	Balance and coordination Learning acquisition, retention and transfer, proprioception, physical activity, body awareness, manual dexterity and ball skills.	M-ABC-2	Results showed a significant difference in the subscales of ball skills and balance performance (P < 0.05) and no significant difference in the manual agility scale (P > 0.05) between the two groups.
Kashefimehr et al. (2018)	Occupational performance Emotional reactions, social responses, auditory processing and motor skills.	SCOPE	The intervention group showed significantly greater improvement in all the SCOPE domains, as well as in all the SP domains, except for the "emotional reactions" and "emotional/social responses" do-mains, (p < .05).
ElGarhy & Liu (2016)	motor skills and body awareness Psychomotor concepts (time, space and corporality)	lista de verificación de Mann-WhitneyUtest onPIP	Psychomotor intervention (PIP) improves motor skills and body awareness That is, 100% of students in the experi-mental group improved between 29% and 51%in body awareness, 17% and 57% in body con-cepts, 21% and 54% in space concepts, and 16%and 50% in overall psychomotor concepts (P= 0,16).
Pan et al. (2017)	Competence in motor skills and executive function	El BOT-2, WCST	There was no significant difference in the participation rate between Group A (90.53%±6.48%) in Phase I of the 12weeks and Group B (88.26%±6.93%) in Phase II of the 12weeks (t=0.80, p=0.44).
Trubanova et al. (2020)	Expression and emotion recognition	FEET, (AR), (NEPSY-II)	There was a significant group difference of medium effect in participants' ability to identify emotions, based on the NEPSY AR test (P= .04).
Hill et al. (2020)	Behavior in the task, level of satisfaction or not	COPM Scores, videos	Goal-directed occupational therapy leads to positive outcomes for children with ASD with or without the inclusion of the dog. (p < 0.01; 95%).6), indicating excellent inter-rater reliability of the on-task behaviour checklist.
Tse et al. (2020)	Emotional regulation behavioral functioning	(ERC-ER), T- score y medida	The intervention group demonstrated significant improvement in emotion regulation and reduction in behavioral problems (p<.05).
Rabeyron (2020)	Symptoms and clinical characteristics of autism	CGI, CARS, ABC.	Music therapy is more efficient when used as a complement to health care programs for ASDs, with great significance for stereotypy and lethargy. In the groups as reflected by a meaningful effect of time (P= < .001) IC 95%.
Wood et al. (2020)	Depression. anxiety and social comunication	BIACA, CASI, DSM-5 Social	the 2 Child Behavior Checklist scales, there was a significant effect for the BIACA group (Anxious and Depressed scale) P < 0.001; Internalizing scale P = 0.007.
Hadoush et al. (2020)	Language and communication, health and physical conditions.	ATEC	Transcranial direct current stimulation is a safe and non-invasive method to stimulate cortical regions. There were significant decreases in total ATEC scores (P = 0.014), sociability sub-scores (P = 0.021), and behavioral, health, and physical condition sub-scores (P = 0.011).
Jin et al. (2020)	Social domain, communication, movement, language and healthy behavior, language and communication; sociability; sensory aware-ness; and behavioral, health and physical conditions	ATEC, ABC	The combined treatment of acupuncture catgut embedding therapy with rehabilitation training improves attention and social communication. there were significant differences in ATEC and ABC scores (P < 0.05).
Mills et al. (2019)	Social domain, behavior	(CBCL), (ASEBA)	Hydrotherapy can improve behaviors that affect the mental health and well-being of children with ASD. Paired-samples t-tests revealed significant improvements post-intervention: Anxious/Depressed subdomain (p = 0.02) and the Inter-nalising Problems Domain Summary (p = 0.026). Thought Problems (p = 0.03) and Attention Problems (p = 0.01) both significantly improved post-intervention.
Hawkins et al. (2019)	Depression. anxiety and social comunication	(STAI-CH)	There was no significant difference between the intervention group and the control group on the posttest heart rate P = 0.957
Phung & Goldberg (2019)	social communications, executive functioning	SCQ, ADOS-2, (BRIEF-2)	The intervention appeared to be effective in improving the executive functioning of children with ASD. In terms of accuracy in the incongruent block, a significant main effect of time (P=.01), IC 95%.
Nowell et al. (2019)	Communication and self-regulation skills	(SCQ)	Significant time by group effects were found for the total COP score p ≤.02, indicating that the intervention group improved their self-regulation and social communication knowledge and skills during the intervention
Marro et al. (2019)	Social knowledge, social cognition, assertiveness behavior Social skills	(SCQ), (ADOS-2) (CABS) (TASSK), (ToMI)	The results indicate that adolescents with ASD can learn these aspects of social cognition implicitly in everyday acts, without being subjected to a structured teaching process. improvements in emotion recognition in low-intensity faces (P < .001), improvements in emotion recognition on the DANVA-2 Face (P > .015)

Gamez et al. (2019)	limb movement speed Movement Time	Movement Time (MT) Percent Time-to-Peak Velocity (% TPV)	The affectation of the motor pattern of walking could be related to the planning of movements within the associative phases of motor learning with Movement Time (MT) and Percent Time-to-Peak Velocity (% TPV) p < 0,05.
Albaum et al. (2019)	Regulation of emotions (sadness, worry and anxiety)	(CEMS), (ERC), (BASC-2 PRS) (ADIS-P)	Task collaboration in subsequent sessions predicted improvements in emotion regulation with (P=0,01).
Voss et al., (2019)	Socialization	VABS-II	Children receiving the intervention showed significant improvements on the Vineland Adaptive Behaviors Scale socialization subscale compared with treatment as usual controls P = 0.005
Maskey et al. (2019)	Behavior, anxiety	(SCAS-P), (SCAS-C), (FSSC-R), (CAPE)	1/3 of the group showed improvements in their specific phobia in real contexts; were able to manage everyday activities and situations that they did not previously.The treatment group showed a statistically significant greater improvement on Target Behaviour ratings compared with the control group, for both baseline to two weeks post treatment (p=0.021)
Wang et al. (2019)	Sociability, emotion and stereotyped behavior.	(ATEC), (ABC)	The experimental group had significant reductions in the scores of irritability, social withdrawal, and stereotypic behavior and the total score of the ABC scale (P<0.05), and the control group had significant reductions in the scores of behavior and inappropriate speech and the total score of the ABC scale (P<0.05)
Germone et al. (2019)	Social communication and Behavior	(ABC-C), (SRS2)	Dog-assisted activities may promote social communication behaviors in psychiatrically hospitalized youth. Overall, social-communication behaviors significantly improved in the animal-assisted activities experimental condition compared to the control condition (p=0.0001).
Parsons et al. (2018)	Social comunication, Joy, pragmatic observation, symbolic game	(CSBS), (MSEL) (ToP)	Research showed improvements in receptive, pragmatic language, and social skills in children with ASD. There was no between-group difference in the change of mean score p>0.05
Tse et al. (2019)	Social comunication, cognition and executive functions	DSM-5 S, (C-WISC) (SRS2)	Physical activity improves sleep quality and cognition among children with ASD. Specific physical activity may be required to benefit individual executive functions. (p= >0.05)
Riquelme et al. (2018)	Proprioception, stereognosis, pain sensitivity, tactile sensitivity	Pressure Pain Thresholds Body location Body side	Repetitive somatosensory stimulation therapy led to decreased pain sensitivity and increased tactile sensitivity leading to development of somatosensory processing. The analyses indicated that pain thresholds at the three body locations were higher p = 0.023.
Sharda et al. (2018)	Social communication, pragmatics, repetitive vocabulary and cognition, quality of family life and adaptive behavior	(CCC-2), (SRS-2), (PPVT-4) (C-WISC), (CI) (WASI-I / II / WISC-IV / V) (FQoL) , ((VABS-MB57)	Interventions of 8 to 12 weeks of individual music intervention can improve social communication and functional brain connectivity.Communication scores were higher in the music group post-intervention (difference score P = .01).Associated post-intervention resting-state brain functional connectivity was greater in music vs. nonmusic groups between auditory and subcortical regions (P < .0001) and auditory and fronto-motor regions (P < .0001).
Padmanabha et al. (2019)	Sensory processing, Function Social, emotional, Physical activity	(CARS), (IQ), (SQ), PRILS-10, (CGAS) PedsQL	Marked improvement was noted especially in reduction of hyperactivity, motor-stereotypies and auditory sensitivity in those who underwent sensory interventions. The mean change in scores in sensory-intervention group on (CGAS) p < 0.011 and PedsQLTM p = 0.008; d = −0.88).
Dekker et al. (2019)	Level of social functioning Specific social skills, at home (Cooperation, assertiveness, self-control and responsibility)	Escalas de comportamiento adaptativo (ESTIA), (ESTIA-TS), (SSRS-P) y (SSRS-T)	The children improved in social functioning in daily life and in general social skills immediately after group training. (P=0,39) IC: 95%.
Morgan et al. (2018)	Participation productivity, social connection, directed communication, language production. General and Expressive Vocabulary, Independent Living Skills, and Social Response	(CMAE), (PPVT-4), (EOWVPT-4),(VABS-II) (SRS), (BRIEF).	The findings support the effectiveness of the classroom intervention implemented by the teacher to improve participation, adaptive communication, social skills and executive functioning. Children in both groups experienced reduced solitary engagement (p<.001) and increased joint engagement (p<.001).
Chang et al. (2018)	Game skills, Receptive and expressive language skills	(ADOS), (PPVT-4), (TCX)	Improved participation in symbolic play was associated with increases in expressive language skills. There was a significant interaction (site by treatment by time) that was observed for the pre-symbolic play types p = 0.0421)
Weiss et al. (2018)	Emotional regulation in sadness, anger, worry, inhibition, and coping, emotional behavior, behavior adaptation skills and anxiety	(CEM), (ERC), (ERSSQ), (BASC - 2), (ADIS - P), (BSI), (CGI)	The children demonstrated significant improvements in measures of emotion regulation and aspects of psychopathology. Children with at least one disruptive disorder, and with both an anxiety and disruptive disorder, had greater levels of parent-reported child emotional lability/negativity at baseline compared to those without disruptive disorders p = 0.03
Yu et al. (2018)	Physical Fitness (throwing, running, jumping and grip strength), non-verbal reasoning, language and visual attention.	(PREFIT), (GRIP-A), (SRPM), (CPEP-3), (PEP-R),(CEIT), (CCTT).	The research showed that the program, if effective, will provide entertaining and engaging training for the holistic development of children with ASD (P= 0,90).
So et al. (2018)	Skills, behavior, gross and fine motor skills	(PEP-3), (BOT)	There were significant correlations between fine motor skills, attention skills, gestural recognition skills, and gestural production performance in the pretests and/or posttests p < 0.07.
Toscano et al.	Autistic traits, physical health and	(CHQ-PF50)	The use of exercise and physical activity is supported, including the basics of coordination and strength in ASD (P=.>

2018)	psychosocial		0,05).
Crawford et al. (2017)	Social affect, social responsiveness, stress, and mental well-being	(ADOS), (PSI-SF), (WEMWBS)	From baseline to 5 months, mean scores of ADOS social affect decreased from 14.1 to 13.3 in music therapy and from 13.5 to 12.4 in standard care with no significant difference in improvement.
Bieleninik et al. (2017)	Social affection, social responsiveness.	(ADOS), (PDD), (ICD-10), (SRS)	Improvisational music therapy did not produce a significant difference in symptom severity according to the social affect domain. (P=0,06) IC 95%
Choque et al. (2017)	Social response, Adaptive behavior, modification of developmental disorders	(SRS), (ABAS-II). (DD-CGAS), (OSU Autism)	Secondary outcomes indicated moderate effects on adaptive functioning and clinical severity P=0.09
Sotoodeh et al. (2017)	Language, sociability, cognitive awareness, health and physical behavior.	ATEC	The results showed that there were differences in the two groups in all subscores (p=0.001).
Yun et al. (2017)	Social behaviors, eye contact	(ADOS).	For facial emotion recognition, the percentages of correct answers were increased in similar patterns in both groups compared to baseline (P > 0.05). The subjects' ability to play, general behavioral and emotional symptoms were significantly diminished after treatment (p < 0.05).
Conaughton et al. (2017)	General level of functioning, behavior, anxiety	(CGAS), (CBCL), (SCAS-C)	The BRAVE-ONLINE program may be helpful in reducing anxiety symptoms in children with HFASD, although the effects are less strong than those found in neurotypical children. P=(p<.001).
Touzet et al. (2017)	Autism symptoms, behavioral adjustment, language level, sensory profile, and parental quality of life.	(DQ), (MSL), (MSL), (ADOS-2), (BOSCC)., (VABS), (CareQuol-7D).	Encouraging the use of ESDM by parents at home and in natural environments of daily life, significantly improves comprehensive, expressive language and expands the possibilities of generating early learning P= 0.05
Petty et, al. (2017)	Animal care, Animal abuse, affective relationship, social interaction	(CABTA). (PACRA)	An increase in positive social interactions is shown in people with ASD when intervened with animal-mediated strategies. (p = 0,013).
Porter et al. (2017)	Social comunication, social functioning, self-esteem, depression and family functioning.	(SSIS)	There was no significant difference for the child SSIS at week 13 p = 0.19) or however, for participants aged 13 and over in the intervention group, the child SSIS communication was significantly improved p = 0.07

Results

Characteristics of participants and interventions

Based on findings retrieved from the 45 articles for final analysis, results related to the characteristics of the population were: number of participants (n=3 439), age range: 8-17 years of age, confirmed diagnosis of autism spectrum disorder with a profile in the levels of severity, which ranged from those with greater involvement to those with highest functionality, prior diagnosis of ASD using Diagnostic and Statistical Manual of Mental Disorders (DSM - IV, and V), Childhood Autism Rating Scale (CARS, secondary outcome), Aberrant Behavior Checklist (ABC, secondary outcome), Clinical Global Impression (CGI-I) and Pediatric Anxiety Rating Scale (PARS).

Regarding characteristics of the interventions, evidence was found on: Alternative therapies (tai-chi – mixed martial arts, acupuncture and yoga), sensory integration, psychomotor intervention, physical activity, physical exercise, animal-assisted therapy, music therapy, transcranial direct current stimulation, hydrotherapy, social skills training, cognitive - behavioral therapy, somatosensory therapy, virtual reality therapy, robot-based therapy, Early Start Denver Model and horse riding. According to the aforementioned information, it was found that six studies compared the effectiveness of virtual reality with different strategies to improve communication, interaction among children, facial expression, visual and motor skills in sensory processing, as well as behavioral work for anxiety in children with autism spectrum disorder. (McKinney, et al., 2020; de Moraes, et al., 2020; Wieckowski, et al., 2019; Parsons, et al., 2019; Sotoodeh, et al., 2017; Conaughton, et al., 2017).

Six studies compared physical activity and exercise versus conventional interventions, with duration of treatments between 12 to 48 weeks aiming to master motor skills, executive functions, emotional regulation, coordination, cognition, metabolism, sleep quality and reduction of stereotyped behaviors in children with autism spectrum disorder (ASD). (Pan, et al., 2017; Andy, 2020; Corral, et al., 2020; Tse, et al., 2019; Clare, et al., 2018; Toscano, et al., 2018).

Five studies presented evidence on cognitive behavioral intervention in processes related to emotional regulation and social components. (Wood, et al., 2020; Albaum, et al., 2020; Voss, et al., 2019; Maskey, et al., 2019; Weiss, et al., 2018).

Five studies presented evidence on music therapy to improve social communication, social affect, stereotypies, lethargy and self-esteem. (CEBM, 2010; Weiss, et al., 2018); Crawford, et al., 2017; Bieleninik et al., 2017; Porter, et al., 2017).

Four studies evaluated the effectiveness of alternative therapies such as tai-chi for motor function, aromatherapy for regulation in anxiety processes, mixed martial arts for executive functions and yoga for communication processes.(Sarabzadeh, et al., 2019; Hawkns, et al 2019; Phung & Goldberg, 2019; Nowell, et al., 2019).

Four studies compared social skills strategies such as social knowledge, social cognition and assertiveness behavior versus conventional therapies. (Lin, et al., 2020; Marro, et al., 2019; Dekker, et a., 2019; Choque, et al., 2017).

Three studies showed the effectiveness of interventions with animals for social interaction and affective relationships such as therapeutic horse riding, behavior during task execution and social behavior during hospitalization using canines. (Hill, et al., 2020., Germone, et al., 2019; Petty, et al., 2017).

Two studies demonstrated the effectiveness of somatosensory therapy versus other types of intervention for emotional reactions and responses in occupational performance. (Riquelme, et al., 2018; Padmanabha, et al., 2019)

One study investigated the effectiveness of the use of the Early Start Denver Model versus other interventions (Touzet, et al., 2017). One study assessed the effectiveness of robotic training in a controlled clinical environment (Nowell, et al., 2019). Another study analyzed gestural production training (So, et al., 2018). One study evaluated transcranial direct current stimulation (TDCS) (Hadoush, et al., 2020). Hydrotherapy (Mills, et al., 2020), symbolic play (Chang, et al., 2018), Coaching (Locke, et al., 2019) and effectiveness of sand play therapy were evaluated as well.

These findings demonstrated heterogeneity of doses between studies, where the average time of each intervention was 45min ± 16.08 minutes (range: 10-90 minutes), the average number of sessions per week was 15.8 ± 1.2 (range: 1-48 sessions per week); the mean number of weeks was 8.5 ± 3.6 (range: 1-16 week).

Outcome measures

Table 3 presents evaluated variables and outcome measures found in the studies: To measure level of sensory perception cognitive and motor control, social motivation and reward were used: Social Responsiveness Scale II (SRS-2) British Picture Vocabulary Scale III (BPVS-III) Dyadic Communication Measure for Autism (DCMA) Brief Observation of Social Communication Change (BOSCC); Balance and coordination: M-ABC-2; Occupational Performance: SCOPE, version 2.2, Emotional reactions, social responses, sedentary lifestyle, auditory processing, motor skills, vestibular processing: SCOPE, version 2.2. Motor Competence and Body Awareness using the checklist and executive functioning with the Test of Motor Proficiency Second Edition (BOT™-2) (Bruininks-Oseretsky), Wisconsin Card Sorting Test (WCST) (measure of reasoning ability - computer version). Expression, facial emotion and capacity for emotion recognition: Computer-assisted interactive program, FEET Facial Affect Recognition (AR) test from the Developmental Neuropsychological Assessment of Development (NEPSY-II). Symptomatology and clinical features of au-

tism: CGI=Clinical Global Impression. CARS=Childhood Autism Rating Scale ABC= Aberrant Behavior Checklist. Emotion regulation and behavioral functioning: (ERC-ER) subscales of emotional regulation T-score and ANCOVA measure. Depression. Anxiety Social communication: BIACA (Depression-Anxiety Scale) CAIS (school and social subscale). Language and communication; sociability; sensory awareness; and behavioral, health, and physical conditions ATEC (Autism treatment evaluation checklist - Autism Research Institute Checklist). Social domain: Child Behavior Checklist (CBCL) Achenbach System of Empirically Based Assessment (ASEBA). Depression. Anxiety Social communication: State-Trait Anxiety Inventory for Children (STAIC). Social communication, Executive functioning and Behavior through the Social Communication Questionnaire (SCQ; Rutter et al. 2003) ADOS-2 (Autism Diagnostic Observation Schedule) Behavior Rating Inventory of Executive Function (BRIEF-2).

Assessment of methodological quality

For methodological quality assessment of studies included, the PEDRo scale was used (Table 1). Most studies obtained a high score, highlighting those published (Hawkins, et al., 2019) and (Chang, et al., 2018) that achieved a rating of 10.

Discussion

Evidence demonstrates that, despite the heterogeneity in manifestations of deficiencies in social functioning, particularly in the dimensions of receptive and expressive language of children diagnosed with ASD, it is possible to achieve objectives related to behavior in the performance of tests that evaluate cognitive and motor control (Pan, et al., 2017; Andy, 2020; Corral, et al., 2020; Tse, et al., 2019; Clare, et al., 2018), social responses (de Morales, et al., 2020; Pan, et al., 2017; Bieleninik, et al., 2017; Choque, et al., 2017), expression and recognition of emotions ((Wood, et al., 2020; Albaum, et al., 2020; Voss, et al., 2019; Maskey, et al., 2019; Weiss, et al., 2018).

In interventions related to motor functions, the greatest challenge was focused on the low frustration tolerance of patients, the control of group sessions and adherence to therapeutic process, particularly in studies with large populations (McKinney, et al., 2020). From this perspective, activities that include the development of sequences approached through symbolic letters, puzzles and categorizing games may be indicated as prerequisites to achieve skills that can support communicative development. These findings are consistent with other studies that demonstrated that physical activity such as Tai Chi Chuan, after six weeks of practice, might have a positive effect on balance, manual skills, but is also useful for regulation of speech skills, sensory regulation and stereotyped behavior (Phung & Goldberg, 2019).

However, due to variability in functioning profiles by levels of severity of ASD, it is likely that interventions need to be tailored to of everyone's symptoms. Likewise, it has been considered that cumulative effectiveness in behavior can be maintained over time, while physical activity programs (García & Gonzalez, 2021) are included accompanying other therapies that address the communication directly, aspects that should be evaluated in future longitudinal studies and meta-analyses (Andy, 2020).

Regarding conductive-behavioral therapeutic approaches, the use of technological resources is associated with a significant reduction in clinical severity of ASD, functioning global assessment, and social manifestations of anxiety. In this regard, previous studies conclude that online interventions such as BRAVE-ONLINE (Conaughton, et al., 2017) are highly beneficial, as they allow maintenance of obtained results, after three months of follow-up. In addition to the therapeutic use of these digital tools, there are other elements of positive weighting, such as the level of satisfaction of parents and patients, who are highly pleased with these methodologies that can be applied at home, and whose functional objectives can be transfer to daily contexts (Wieckowski, et al., 2019). These results are related to findings from other studies which demonstrated statistically significant improvements in receptive language, pragmatic and social skills using tablets as mediators of the communicative process (Parsons, et al., 2019).

These data are useful for multidisciplinary rehabilitation teams to include in their interventions the use of information and communication technologies (ICT) to achieve social skills, that motivate children with ASD and their caregivers (Bravous et al., 2022).

It is important to acknowledge that, in recent years, strategies have diversified to respond to behavioral needs of children with ASD. In this way, music therapy has been used to manage lethargy and stereotypies. These results are usually obtained from 8-month duration structured programs, a dose of 25 sessions could induce the achievement of vestibular-origin motor skills that contribute to adaptation of participants and reduction of symptoms. Since this is a chronic condition, it is important to highlight that a sufficient number of sessions are required to notice the clinical improvements and to ensure its stability over time. To complement these statements, other studies have reinforced the utility of music therapy which demonstrated that, based on nervous system structural phenomena, it increased functional connectivity between the primary auditory cortex, subcortical and motor regions, which is often reduced in children with ASD; indicating a connection between changes of sensorimotor networks, and improvements in behavior. Since early motor difficulties are predictive of communication impairments, it is estimated that musical training programs aimed at motor skills may have a later impact on social behavior (Porter, et al., 2017).

Another emerging intervention in alternative therapies is aromatherapy, which based its use on reduction of anxi-

ety responses in daily scenarios such as medical offices. According to its theories, a substance enters the body through an olfactory stimulus and reaches the limbic system, amygdala and hypothalamus to impact emotions and memory. Based on this action mechanism, once the aroma is captured and combined with a pleasant experience, the memory would be able to generate an association between the smell and the feeling of security.

Although contributions in this field are still emerging, the use of bergamot oil has shown to be of great utility for manage these behaviors in populations with neurotypical development. However, its application in studies performed with children with ASD has not provided positive results; on the contrary, it has been noticed that it may increase subjective feelings of insecurity in spaces of social interaction and high confluence as are found in medical centers (Hawkins, et al., 2019).

Concerning the inclusion of animals as support in therapeutic processes, interaction with dogs in low-functioning hospitalized children contributed significantly to verbal communication. However, during observation periods of interventions, no significant modifications were identified in prosocial behaviors such as getting involved in help situations or achieving physical contact with peers. It is important to highlight that these studies did not consider these conditions or opportunities; therefore, these findings cannot be assumed as being conclusive (Wieckowski, et al., 2019; Germone, et al., 2019).

Regarding the use of horses, after a period of 10 weeks of treatment, participants exhibited significant improvements interacting in solidarity at home with their families and expressing affection to pets, as reported by the caregivers. Nevertheless, authors have recognized some weaknesses in these studies in relation to sample size, and validity of the instruments for measuring results; so findings could be biased toward overestimation due to a ceiling effect of pre- and post-intervention measurements.

In accordance to the aforementioned, it is projected for future evaluation in research exercises, how human-animal interaction can affect family functioning; it could also be useful to acknowledge how the animal-induced behavior modification of children with ASD could benefit relationships at home (Petty, et al., 2017).

This study provides relevant information for teams that work with this type of populations, since management options can be applied by health and rehabilitation professionals from inter and trans-disciplinary approaches and, can lead to the development of new randomized control trials or studies that address complementary issues associated with prosocial behaviors specifically, for which sufficient evidence has not yet been reported.

Concerning the limitations of this review, the difficulty in blinding the participants by the type of population approached, do not allow to define conclusively which would be the best strategy for behavior modification within the autism spectrum. In this regard, it is considered that prescription of intervention processes from integrative approaches that include family, educators, and health staff, as well as the adaptation of strategies according to the characteristics, needs and, that are motivating for patients, could be useful recommendations, until better evidence is available.

Conclusion

The analysis of studies included in this systematic review allow the authors to conclude that there are several strategies used for behavior management in autism spectrum disorder, the use of technological tools stands as a promising option as they are highly beneficial and contribute to achieve behavioral objectives, that can be applied in daily life scenarios and that can be maintained over time in an estimated average of three months. However, it should be noted that there is no consensus regarding the prescription of intervention activities, since there are no defined protocols that respond to the functional diversity described in this disorder, and most of the studies that reported significant changes had subjects with higher levels of cognitive development and adaptive capacity.

Conflict of interest

Authors declare no conflicts of interest.

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