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Research paper

Cognitive behavioural therapy to improve social skills in children and adolescents with autism spectrum disorder: A meta-analysis of randomised controlled trials

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ABSTRACT

Background: Cognitive behavioural therapy (CBT) is effective in treating various neurological and psychiatric diseases. It improves anxiety symptoms in children with autism spectrum disorder, gaining considerable empirical support. However, social skills results are mixed, leading to debate over its effectiveness, highlighting the need for further development. While the Social Responsiveness Scale (SRS) is a secondary indicator to measure anxiety symptoms, it primarily evaluates social skills, which are essential for rehabilitating children with autism. Therefore, evaluating social disorder improvement in children with autism is imperative. Social impairment is a core autism symptom. Therefore, we conducted a systematic review of randomised controlled trials assessing the effects of CBT on social skills in this population.

Methods: We reviewed articles published in several databases through October 2022 and relevant reference lists. We used the standardised mean difference (SMD) as the main effect size indicator and focused on SRS metrics from baseline to endpoint. We analysed subgroups, heterogeneity, bias risk, and publication bias.

Results: Our meta-analysis included 214 children from seven randomised controlled trials with nine datasets. Forest plot analysis shows CBT improved social skills in children with autism compared to controls. Subgroup analysis revealed parents' and teachers' SRS scores for children, SRS scores of CBT versus waitlist controls, and those of CBT versus non-waiting-list controls.

Limitations: Most randomised controlled CBT trials for children with autism have explored anxiety symptom improvement. Further, social skill assessment was a secondary outcome or not assessed. Thus, social skills data are insufficient.

Conclusions: CBT is effective in improving social impairment in children with autism.

Registration: This meta-analysis was registered with the International Prospective Register of Systematic Reviews (CRD42022363423).

1. Introduction

Autism results from altered early brain development and neural reorganisation (O'Reilly et al., 2017; Bauman and Kemper, 2005). It is a neurodevelopmental disorder that begins early in development, characterised by social impairment, narrow interests, and stereotypical behaviours (American Psychiatric Association, 2013). The World Health Organization estimates the worldwide prevalence of autism at 0.76 %. Therefore, autism affects approximately 16 % of the global child population (Baxter et al., 2015). The cause of autism is unknown, and its symptoms can persist into adulthood, accompanied by physical impairment and disability, making its diagnosis and treatment complex (Howes et al., 2018). Additionally, studies have shown that up to 70 % of individuals with autism have at least one co-occurring mental health condition, including genetic or psychiatric disorders (Lai et al., 2019). Signs of autism during early childhood include limited eye contact, poor response to names, lack of display and sharing, absence of gestures for 12 months since birth, and loss of language and social skills. In preschool, autism signs include limited pretend play, strange or highly focused interests, and stereotypical behaviours. School-age children may struggle to understand emotions and show interest in peers but lack conversational skills or appropriate socialisation (Hodges et al., 2020).

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Social dysfunction is one of the core autistic features. Indeed, studies have found that children with autism are less active in social situations than typically developing peers, regardless of their cognitive abilities (Taheri et al., 2016; Kasari et al., 2011). Children with autism tend to have smaller networks of friends and perceive their friendships as lacking companionship and security. Therefore, they receive little help from friends (Kasari et al., 2012; Smith et al., 2007; Laugeson et al., 2009). Social impairment in children with autism increases with age, becoming more pronounced in adolescence when more social skills are required (Picci and Scherf, 2015).

Cognitive behavioural therapy (CBT) is an evidence-based psychosocial practice originally developed to treat depression in adults. However, it has since expanded to many other areas, such as modular CBT for childhood anxiety disorders (Guilford Press, 2006). As a form of collaborative psychotherapy, CBT can be offered in various formats to individuals, children, adolescents, groups, parents, and families. One of the first manualised curricula for CBT was the Coping Cat (Kendall, 1994), which included education, inability to modify cognition, exposure, social competence training, coping behaviours, and self-reinforcement sessions. Several programmes have since been adapted specifically for children with autism, including the TAFF (Schneider et al., 2011), the Multimodal Anxiety and Social Skills Intervention (White et al., 2013), and the Facing Your Fears programmes (Reaven et al., 2012). Evidence shows CBT positively impacts children with autism (Wood et al., 2021; Tanksale et al., 2021; Wood et al., 2020). Several meta-analyses (Ung et al., 2015; Sharma et al., 2021; Weston et al., 2016; Perihan et al., 2020) have suggested that CBT may effectively improve anxiety symptoms in children with autism. In addition, some studies have found that CBT is the common therapeutic element in evidence-based social skills training interventions (Laugeson and Park, 2014). However, no meta-analyses have examined the effects of CBT on social skills in children with autism. Therefore, this meta-analysis investigated whether CBT improves social impairment in children and adolescents with autism.

The Social Responsiveness Scale (SRS) is a 65-item instrument that measures the severity of autism symptoms and is most commonly used for children and adolescents aged 4–18 years (Bölte et al., 2008). The SRS assesses children's behaviour over the past six months using a four-point Likert scale (1 = *never*; 4 = *almost always*), with higher scores indicating more severe symptoms. This measure, completed by parents (SRS-P) or teachers (SRS-T), has been widely used in child research due to its ease of administration and ability to produce psychometric results (Constantino et al., 2003). Several studies have shown that the SRS is reliable and valid in measuring autism symptoms among children and adolescents aged 18 years or younger (Bölte et al., 2008; Gau et al., 2013; Wigham et al., 2012). In addition, the SRS has good screening sensitivity (Aldridge et al., 2012; Duvekot et al., 2015; Moul et al., 2015). The scale focuses primarily on a comprehensive multidimensional social skills evaluation with relevant entries accounting for 53 of the 65 items. The remaining 12 items assess autistic habits (Cen et al., 2017). Therefore, we chose the SRS to assess social impairment and its severity in children and adolescents with autism.

2. Methods

This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. In addition, this systematic review includes a complete list of the search terms registered in Prospero (CRD42022363423).

2.1. Search strategy

We searched all articles published in the PubMed, Embase, and Cochrane Library databases up to October 2022. After a group discussion, we developed and refined the search strategy. We used 'Autism Spectrum Disorder,' AND 'Cognitive Behavioral Therapy,' AND 'Randomized Controlled Trial' as subject and their related free terms. The titles and abstracts of the retrieved articles were screened to identify relevant studies. Full-text peer-reviewed papers were searched, and their reference lists were screened to identify additional relevant studies. The methods section of the retrieved literature was abstracted and independently reviewed by two researchers (Xiao-Rui You and Xing-Ruo Gong) according to predefined criteria. The two researchers followed the blindness principle when analysing the manuscript titles, authors, journals, and results. Disagreements or ambiguities were resolved through discussion with a third researcher (Mei-Ran Guo).

2.2. Selection of studies

The following inclusion criteria were used: (1) studies followed a randomised controlled trial; (2) participants were children and adolescents ($\leq$18 years of age) diagnosed with autism; (3) the intervention was CBT and was compared with other non-CBT interventions; and (4) SRS (at least $\geq$1 measure per article) was included. The exclusion criteria were as follows: (1) studies did not strictly follow a randomised controlled trial; (2) included participants aged >18 years; (3) the intervention was not CBT; and (4) no SRS measures were available.

2.3. Data extraction

Excel was used to record information for each study in the meta-analysis, including year, number of participants in each group, type of control condition (e.g., waiting list, treatment as usual, or other treatments), study design, and SRS score. The extracted participant characteristics included mean age, gender, and diagnosis. For treatment characteristics, the CBT intervention plan, the treatment, and its duration were extracted. Two researchers extracted the data (Xing-Ruo Gong and Mei-Ran Guo) and examined and discussed it with the entire study research team if any discrepancies arose.

2.4. Data analysis

Information on methods (i.e., design, participants, interventions, and measures) and outcomes (i.e., number of included cases and SRS) was extracted by two researchers (Xiao-rui You and Xing-Ruo Gong) and checked by two additional researchers (Mei-Ran Guo and Bing-Xiang Ma). The corresponding author was contacted to provide details if no information was available in the published trials. We used STATA 17 (STATA, College Station, TX, USA) to conduct a meta-analysis, compare the differences between trial and control groups in the mean post-intervention SRS results, and calculate effect sizes using the post-intervention mean and standard deviation (SD) values. The authors were contacted to obtain this information for studies that did not report the mean and SD values. Studies lacking other statistical tests requiring effect size calculations and those for which the authors did not respond to the questions were excluded. Additionally, only studies that provided SRS results were included.

Standardised mean differences (SMD; Hedges' g) were calculated for all meta-analyses using a random-effects model to account for clinical and methodological differences between trials. Hedges' g was derived from a variation of Cohen's d, which corrects for the small sample size due to bias associated with small sample sizes (Grissom and Kim, 2005). Effect sizes (ES) were expressed as Hedges' g with 95 % confidence intervals (CI), with absolute ES values of 0.2–0.49 considered to produce a relatively small effect, 0.5–0.79 considered to produce a moderate effect, and 0.8 and above considered to produce a large effect (Faraone, 2008). Heterogeneity tests were used (I^2) to assess the heterogeneity of the study, where I^2 values were as follows: 0 %–40 %: representing small heterogeneity; 30 %–60 %: representing moderate heterogeneity; 50 %–90 %: representing large heterogeneity; and 75 %–100 %: representing considerable heterogeneity (Higgins and Green, 2008).

2.5. Risk of bias

The internal validity of the included studies was assessed using the risk-of-bias tool based on the Cochrane Collaboration for the Assessment of Risk of Bias in Randomised Controlled Trials. This tool was used to assess different areas of bias using six criteria: selection bias (criteria 1 and 2), implementation measurement bias (criteria 3 and 4), attrition bias (criterion 5), reporting bias (criterion 6), and other biases (criterion 7). Each study was evaluated for risk of bias based on the same options, including 'low risk of bias' ('green'), 'high risk of bias' ('red'), or 'unclear risk of bias' ('yellow'). Two researchers (Xing-Ruo Gong and Mei-Ran Guo) independently performed a risk assessment for study selection.

3. Results

Using an electronic search strategy, we identified 1730 papers, including 654 in PubMed, 704 in Embase, and 372 in the Cochrane Library. Finally, seven qualitative and quantitative synthesis studies (Wood et al., 2009; Storch et al., 2013; Koning et al., 2013; Wood et al., 2015; Storch et al., 2015; Luxford et al., 2017; Murphy et al., 2017) were included, which contained nine sets of data from 214 children with autism. The filtering steps and reasons for exclusion are illustrated in Fig. 1.

3.1. Characteristics of included trials

Seven studies included data from 214 participants (Table 1), ranging in age from 7 to 18 years, with 110 participants in the intervention and 104 in the control group. The sample sizes ranged from 7 to 24 participants in the intervention group and 8 to 21 in the control group. Across all randomised controlled trials, the mean baseline SRS score ranged from 74.85 to 110.3, and all seven studies reported SRS-P/T. In addition, parents reported SRS-P (k = 7), and teachers reported SRS-T (k = 2). The control group had three main treatment options: waiting for treatment (k = 4), conventional treatment (k = 2), and other treatments (k = 1). No adverse events or hazards were reported in the seven included studies.

Most of the included studies used a modified version of CBT for children with autism. Behavioural Interventions for Anxiety in Children with Autism (BIACA; k = 3), Building Confidence (k = 1), Exploring Feelings (k = 1), and Multimodal Anxiety and Social Skills Intervention (k = 1).

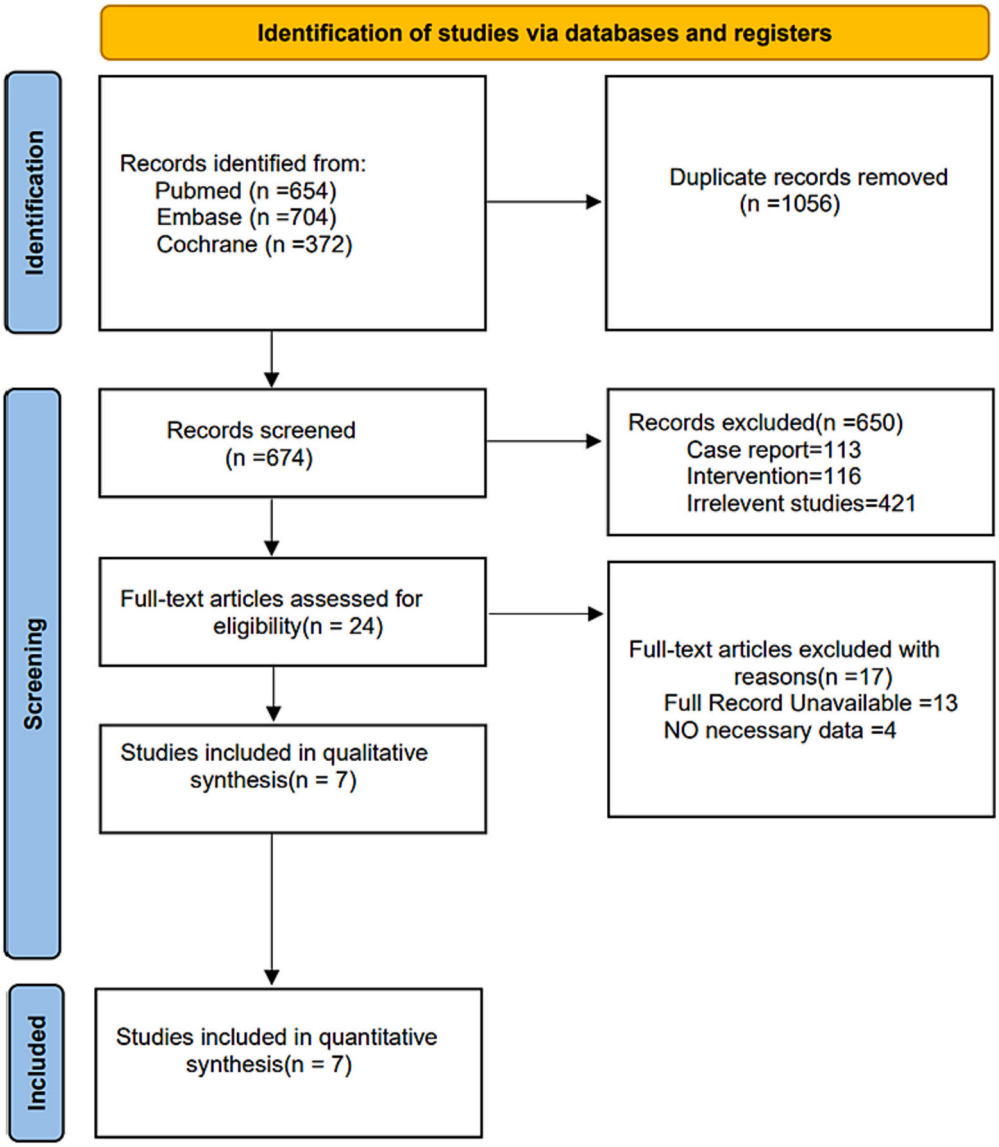

Fig. 1. Flow chart of literature inclusion process.

Table 1
Eligible randomised controlled trials.

Study	Year	Age (yr)	No. (intervention/ control)	Gender	Outcome	Intervention (type)	Control	Diagnosis	Duration	Follow-up	Baseline		Post-treatment	
											Intervention	Control	Intervention	Control
Wood	2009	9.37	9/10	M = 16; F = 3	SRS-P	CBT (building confidence)	WL	Autism & anxiety disorder	16 weeks	3 months	113 (18.27)	116.4 (30.19)	89 (26.39)	110.3 (29.22)
Storch	2013	8.89	24/21	M = 36; F = 9	SRS-P	CBT (BIAC)	TAU	Autism & anxiety disorder	16 weeks	3 months	100.83 (25.10)	110.14 (22.41)	88.88 (19.85)	106.19 (26.00)
Koning	2013	11.07	7/8	M = 15; F = 0	SRS-P	CBT	WL	Autism	15 weeks	NA	80.71 (5.22)	85.00 (6.39)	74.85 (11.61)	79.62 (9.53)
Wood	2014	12.3	19/14	M = 23; F = 10	SRS-P	CBT (BIACA)	WL	Autism & anxiety disorder	16 weeks	1 month	108.41 (19.08)	113.25 (22.49)	82.56 (16.34)	105.75 (11.89)
Storch	2015	12.74	16/15	M = 25; F = 6	SRS-P	CBT (BIACA)	TAU	Autism & anxiety disorder	16 weeks	1 month	105.94 (22.64)	112.93 (24.77)	80.94 (26.83)	107.40 (24.53)
Luxford	2016	13.2	18/17	NA	SRS-P	CBT (exploring feelings)	WL	Autism & anxiety disorder	6 weeks	6 weeks	111.83 (25.24)	114.06 (23.72)	98.56 (23.67)	109.41 (24.68)
Luxford	2016	13.2	18/17	NA	SRS-T	CBT (Exploring feelings)	WL	Autism & anxiety disorder	6 weeks	6 weeks	96.56 (31.44)	89.24 (37.79)	87.94 (29.12)	92.88 (37.80)
Murphy	2017	15.25	17/19	M = 22; F = 14	SRS-P	CBT (MASSI)	Counselling	Autism & anxiety disorder	12 individual sessions and 5 group sessions for both CBT and counselling arms	12 weeks	110.50 (15.30)	107.52 (8.68)	99.92 (14.87)	103.85 (10.12)
Murphy	2017	15.25	17/19	M = 22; F = 14	SRS-T	CBT (MASSI)	Counselling	Autism & anxiety disorder	12 individual sessions and 5 group sessions for both CBT and counselling arms	12 weeks	78.93 (10.83)	75.76 (8.81)	80.10 (7.10)	78.55 (11.87)

M Male; F female.
WL waitlist; TUA treat as usual.
BIACA: Behavioural Interventions for Anxiety in Children with Autism; MASSI: Multimodal Anxiety and Social Skills Intervention.
[a]Summary data are presented as mean.
[b]Summary data are presented as mean (SD).

3.2. Risk of bias

The risk of bias is shown in Figs. 2 and 3. Among the included studies, none maintained a low risk of bias in assessing the seven methodological items. The risk of bias was low for selection bias (criteria 1 and 2), loss bias (criterion 5), reporting bias (criterion 6), and other biases (criterion 7) in all included studies. Concerning blindness, all included studies were judged to have a high risk of bias for person-blindness (criterion 3) and an undefined bias (criterion 4). Four of the seven trials showed a high risk of bias associated with the participant, and one showed an undefined risk associated with the assessment.

3.3. Effect of CBT compared with no/non-CBT intervention

Seven studies, including nine groups with data from 214 children with autism, examined the effects of CBT and non-CBT interventions on SRS scores. The forest plot analysis showed the effect of CBT on the social skills of children with autism in seven included studies (Fig. 4; SMD: −0.55; [95%CI: −0.88 to −0.22]). The sensitivity analysis (Fig. 5) demonstrated that the heterogeneity of different studies was $I^2 = 48.29$ %.

The subgroup analysis showed that nine data groups were included in the seven studies, with the rating of the child's SRS by the parent labelled Group 1 and the teacher labelled Group 2. The forest plot (Fig. 6) revealed the rating of the child's SRS by the parent (SMD: −0.73; 95 % CI: −1.04 to −0.42; $I^2 = 21.77$ %) and by the teacher (SMD: −0.01; 95 % CI: −0.45 to −0.46; $I^2 = 0.00$ %).

There were six interventions in the seven control groups: waiting list (k = 4) and non-waiting list (k = 3). We labelled the waiting list Group 1 and the non-waiting list Group 2. The forest plots (Fig. 7) revealed CBT versus waiting-list controls (SMD: −0.64; 95 % CI: −1.13 to −0.15; $I^2 = 51.28$ %) and CBT versus non-waiting-list controls (SMD: −0.46; 95 % CI: −0.95, −0.02; $I^2 = 55.39$ %).

3.4. Publication bias

The funnel plot (Fig. 8) showed a possible publication bias in this study. For further confirmation, Egger's test and the check-complementary method test were performed (Fig. 9). Egger's test produced a *p*-value of 0.784, and the test of complementarity showed an estimate of −0.548 (95 % CI: −0.876 to −0.221).

4. Discussion

To the best of our knowledge, this study was the first to examine the use of CBT to improve social skills in children with autism. CBT has been

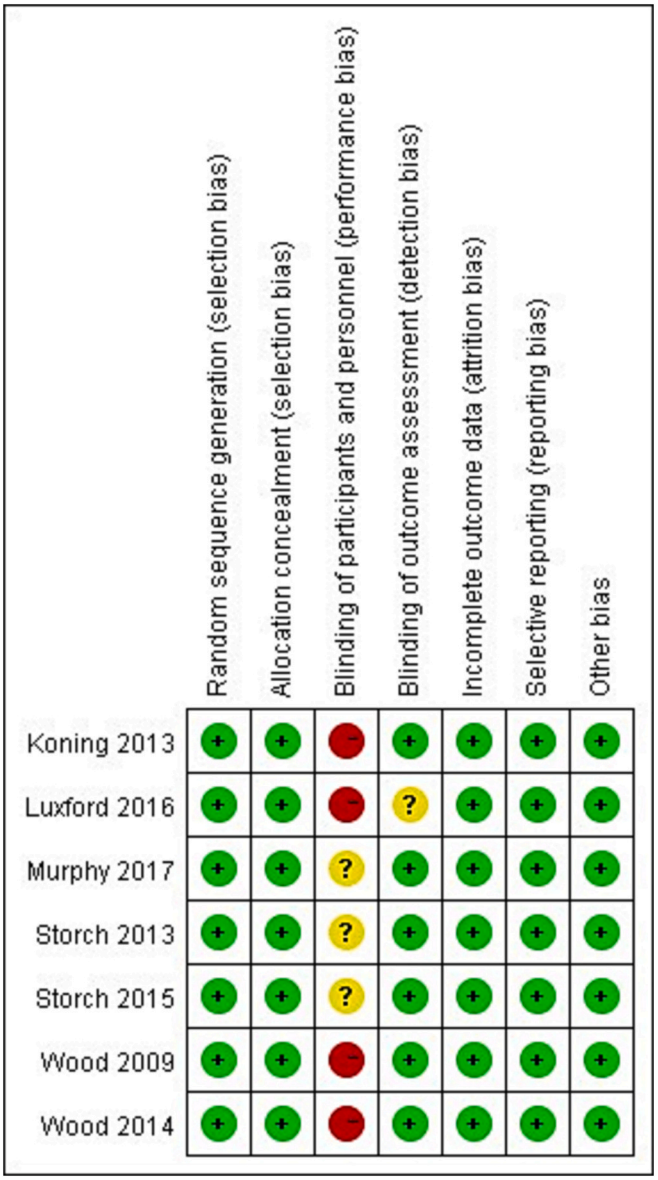

Fig. 3. Risk of bias summary.

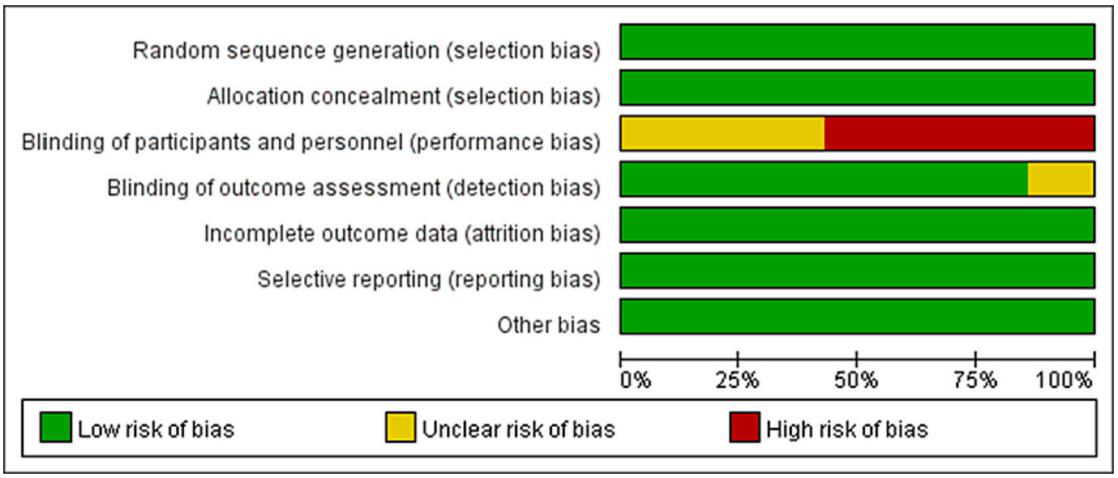

Fig. 2. Risk of bias graph.

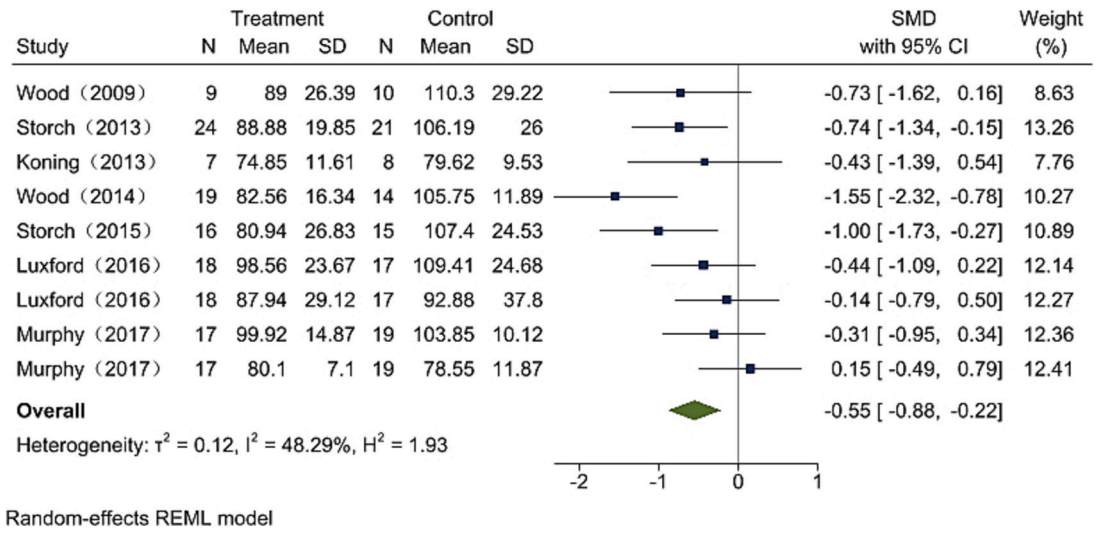

Fig. 4. Forest plot of the effect of CBT on SRS scores in children with autism.

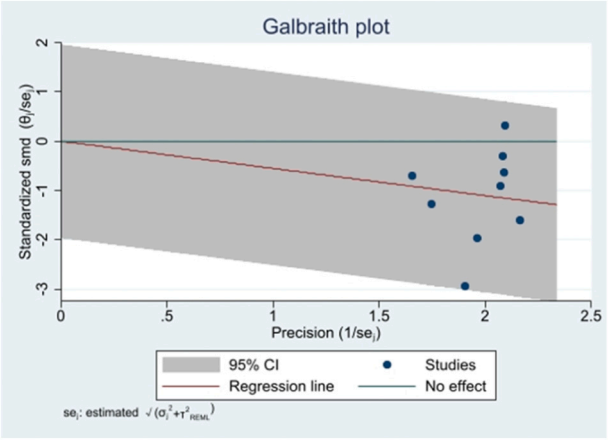

Fig. 5. Sensitivity analysis of CBT on SRS scores in children with autism.

used in numerous randomised controlled trials to improve anxiety symptoms in children with autism (Wood et al., 2021; Tanksale et al., 2021; Weiss et al., 2018; Albaum et al., 2020; Maddox et al., 2017; Drahota et al., 2011; Reaven et al., 2012; Wood et al., 2014). Ung et al. (2015), Sharma et al. (2021), and Weston et al. (2016) performed meta-analyses on this topic, and the analyses were well-validated. In these randomised controlled trials, SRS scores were used as secondary outcomes, as SRS scores were not highly sensitive to alleviating anxiety symptoms. Of the 65 items included in the SRS, 52 evaluate social skills. Therefore, we believe that SRS is more effective in evaluating social skills than anxiety symptoms.

Seven studies were included, with nine datasets and 214 children and adolescents with autism; of these, eight datasets, including six studies with 199 children and adolescents with autism, revealed comorbid anxiety symptoms. In the risk of bias assessment, we found that none of the studies was entirely at low risk, as psychoeducational therapy interventions do not guarantee the principle of participant masking, which is a limitation of all psychotherapy and physical therapy and is difficult to avoid.

All seven studies assessed the social skills of children and adolescents with autism by SRS scores, and CBT was found to improve the social skills of children and adolescents with autism using a forest plot (Fig. 4). The sensitivity analysis (Fig. 5) showed moderate heterogeneity in this study. In the seven studies, nine datasets provided SRS scores, including scores by parents (k = 7) and teachers (k = 2). The forest plots using subgroup analysis (Fig. 6) showed that the SRS scores assigned by parents of children with autism had little heterogeneity and were reliable ($I^2 = 21.77$ %). Therefore, we believe that the teachers' SRS scores may be a source of heterogeneity in this study, which may be related to insufficient research using teacher evaluations. In addition, Hallett et al. (2013) found that teachers' assessments of children may be more objective than those of anxious parents who overestimate their child's condition, which may also be a source of heterogeneity in this study. In this regard, we need to increase the sample size and include more articles exploring teachers' ratings of children with SRS and compare them with parents' ratings in future in-depth studies.

Three control groups were present in seven studies. Four of the studies included waitlists. However, the forest plot (Fig. 7) showed that a control group with a waitlist did not affect the outcome of CBT in improving social skills in children and adolescents with autism. Conversely, the non-waiting-list control group influenced the outcomes of CBT on the social skills of children and adolescents with autism. In our analysis, this finding may be related to the fact that the control measure of Murphy et al. (2017) was not a conventional treatment but nondirective versus supportive counselling. This finding may also be related to the study's inclusion of teachers as a relatively objective assessment group.

To examine the publication bias of the seven studies, including nine data sets, we plotted the funnel plot (Fig. 8) and the check-and-complement method (Fig. 9). Egger's test and the check-and-complement test showed no publication bias in this study, and the study results were reliable.

4.1. Limitations

A limitation of this study is that relatively few studies were included, as most of the randomised controlled trials of CBT interventions for children with autism have been biased toward exploring CBT to improve anxiety symptoms in children with autism. Social skill assessment was a secondary outcome, or the studies did not assess children's social skills. Therefore, the data are insufficient. In addition, to the best of our knowledge, the SRS has been updated with a new version, and some existing studies used the SRS-II to assess autism symptoms and socialisation in children. Relatively few randomised controlled trials have applied this updated scale to assess children with autism, which contributed to the small number of included studies. More randomised controlled trials are needed to explore the evidence that CBT improves social skills in children and adolescents with autism and assess them using a uniform research scale to provide a larger sample size for

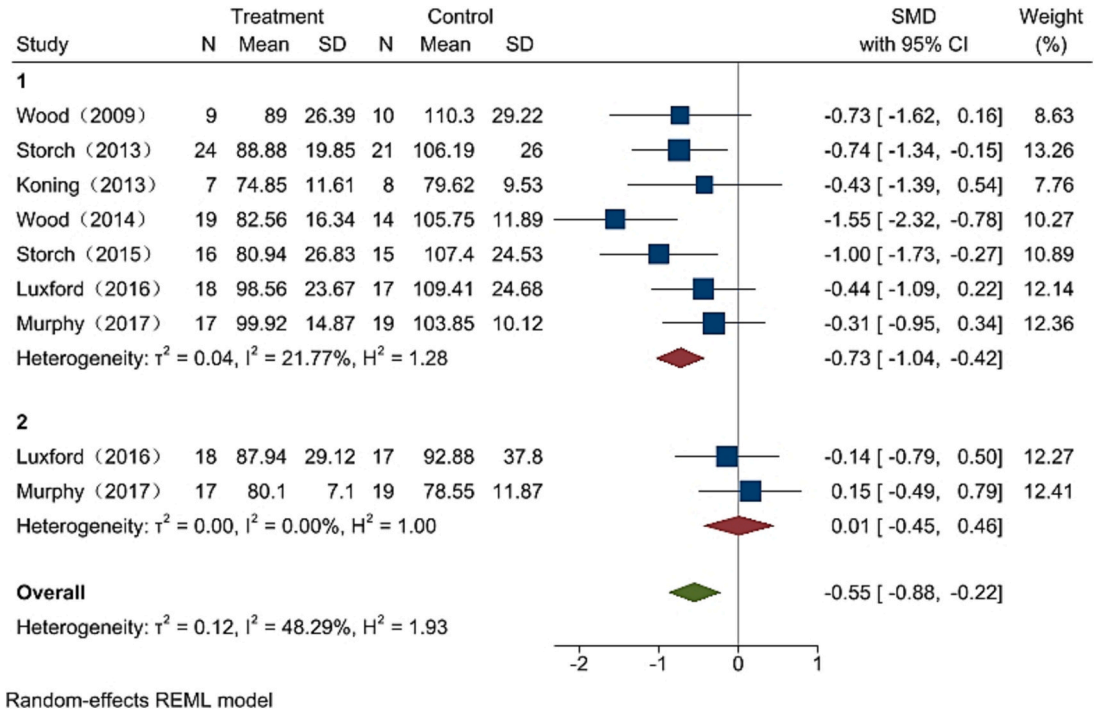

Fig. 6. Forest plot of (1) parent and (2) teacher influence on SRS scores.

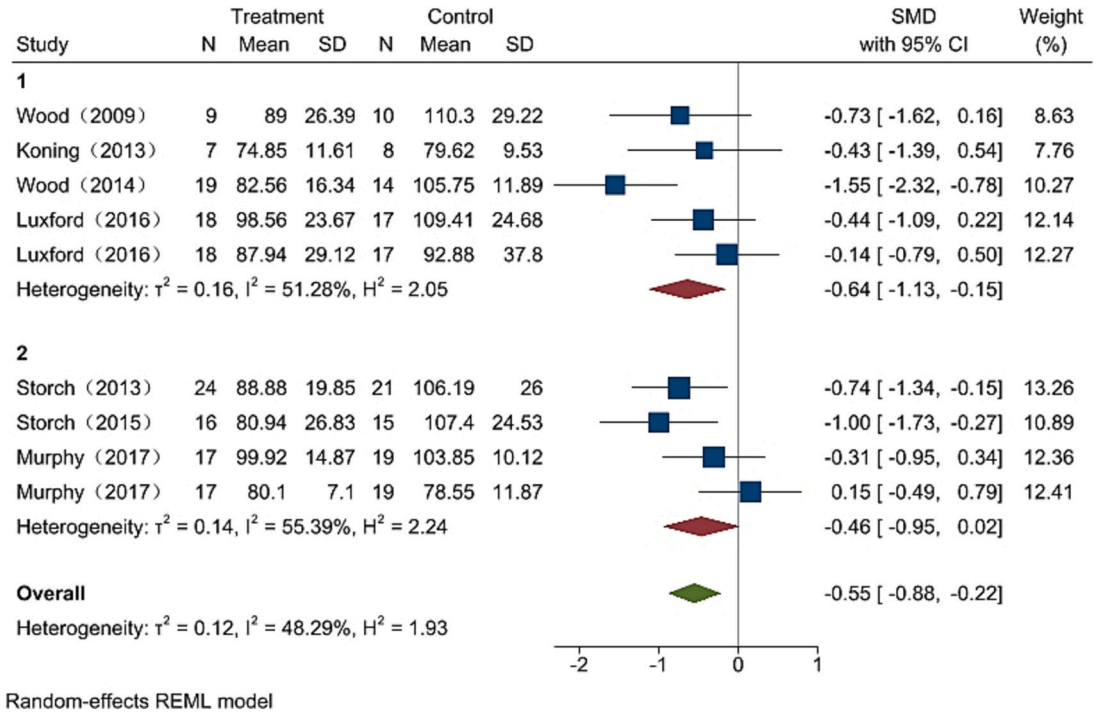

Fig. 7. Forest plot of waitlist vs. non-waiting-list impact on SRS scores.

subsequent meta-analyses.

5. Conclusions

The abovementioned randomised controlled trials and meta-analyses revealed that CBT is essential in improving anxiety symptoms in children and adolescents with autism. Our meta-analysis shows that CBT can also improve social skills in children and adolescents with autism. Although social skills are often assessed as secondary outcomes in most randomised controlled trials, social disorders are a significant concern for children with autism. Therefore, CBT represents a comprehensive treatment modality that can improve both anxiety symptoms and social skills in children with autism. Therefore, it can be considered a multi-faceted treatment approach worthy of clinical application.

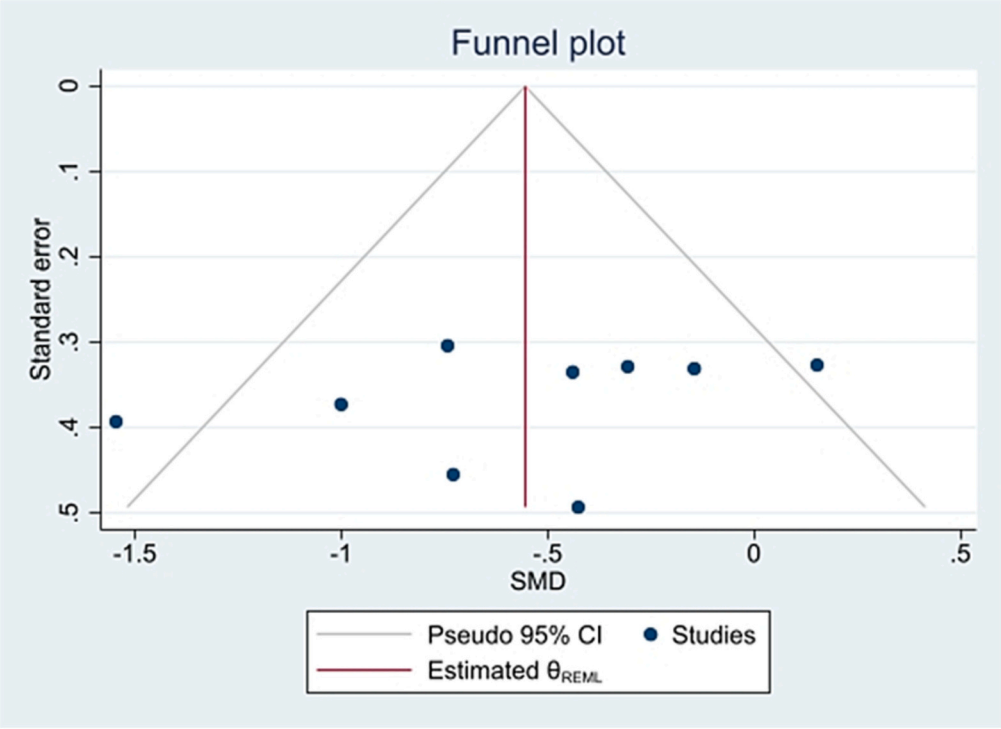

Fig. 8. Publication bias funnel plot of CBT for meta-analysis of SRS scores among children with autism.

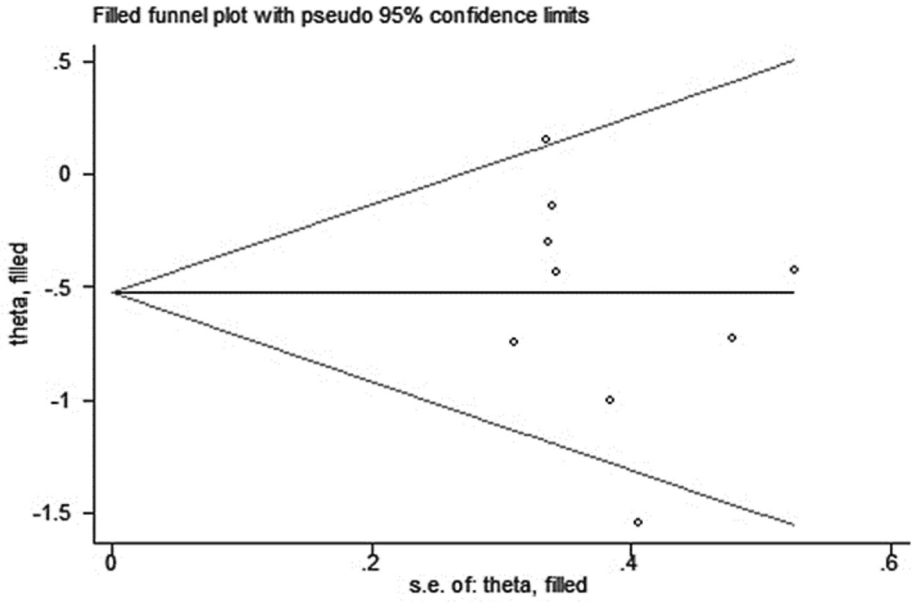

Fig. 9. Trimmed and filled funnel plots for a meta-analysis of the effect of CBT on SRS scores among children with autism.

CRediT authorship contribution statement

Xiao-Rui You and Xing-Ruo Gong performed the literature search, collected the data, wrote the manuscript, and made edits. Xiao-Rui You and Mei-Ran Guo were mainly responsible for interpreting the data and preparing the final version. Bing-Xiang Ma created the figures. All authors provided critical feedback and contributed to the final manuscript. Correspondence and requests for materials should be addressed to Bing-Xiang Ma.

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Declaration of competing interest

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

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None.

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