



Review



Emotion regulation and emotion dysregulation in children and adolescents with Autism Spectrum Disorder: A meta-analysis of evaluation and intervention studies

Damián Restoy^a, Montserrat Oriol-Escudé^a, Teresa Alonzo-Castillo^a, María Magán-Maganto^b, Ricardo Canal-Bedia^b, Emiliano Díez-Villoria^b, Laura Gisbert-Gustemps^{a,c,d}, Imanol Setién-Ramos^e, María Martínez-Ramírez^a, Josep Antoni Ramos-Quiroga^{a,c,d,e}, Jorge Lugo-Marín^{a,b,c,d,*}

^a Department of Psychiatry, Hospital Universitari Vall d'Hebron, Barcelona, Catalonia, Spain

^b Centro de Atención Integral al Autismo-InfoAutismo. INICO-Instituto Universitario de Integración en la Comunidad, University of Salamanca. Salamanca, Spain

^c Biomedical Network Research Centre on Mental Health (CIBERSAM), Madrid, Spain

^d Department of Psychiatry and Legal Medicine, Universitat Autònoma de Barcelona, Barcelona, Catalonia, Spain

^e Psychiatric Genetics Unit, Vall d'Hebron Research Institute (VHIR), Barcelona, Catalonia, Spain

ARTICLE INFO

Keywords:

Autism spectrum disorder
Emotion regulation
Emotion dysregulation
Children
Adolescents
meta-analysis

ABSTRACT

Children and adolescents with Autism Spectrum Disorder (ASD) often experience challenges in emotion regulation (ER) and emotion dysregulation (ED) which can interfere with their adaptive functioning. This study aimed to systematically review and meta-analyze the evidence on ER/ED in children and/or adolescents with ASD, examining its relationship with the following variables: internalizing and externalizing symptoms, cognitive function and social skills, and the effectiveness of non-pharmacological interventions addressing ER difficulties. Both electronic and manual searches were conducted to identify potential studies. Fifty-five studies were included in the meta-analysis. A statistically significant between-group difference was found, suggesting greater ER/ED challenges in the ASD group. Also, the ASD group showed more maladaptive ER strategies and fewer adaptive ER strategies compared to the non-ASD participants. Additionally, more severe ASD and poorer social skills were associated with greater ED and poorer ER skills, respectively. Furthermore, there was a significant correlation between internalizing symptomatology and both adaptive and maladaptive ER strategies. Studies of non-pharmacological interventions showed significant improvement in both ER and ED. These results imply that assessing ER/ED in children and adolescents with ASD should be part of the evaluation process, and it should also be a focal point for intervention in this population.

1. Introduction

Autism Spectrum Disorder (ASD) is characterized by deficits in social communication and by restrictive and repetitive behaviors (American Psychiatric Association, D, and Association, A. P., 2013). These symptoms must have been present since childhood and interfere with daily functioning. The prevalence of ASD stands at approximately 1%, with it being notably more common in males, –four times more prevalent than in females (Zeidan et al., 2022). However, this disparity might be influenced by challenges in identifying autistic profiles in females (Driver & Chester, 2021; Ratto et al., 2018). It is considered that the

heritability of ASD ranges between 64% and 91% (Tick et al., 2016), although there are also cases that result from mutations or polygenic factors.

Mental health disorders are significantly prevalent in individuals with ASD (Hossain et al., 2020; Lai et al., 2019; Lugo-Marín et al., 2019). It has been reported that Attention Deficit Hyperactivity Disorder (ADHD), behavioral disorders, depressive symptoms and anxiety disorders are common in children with ASD (Lecavalier et al., 2019; Rosenberg et al., 2011). The severity of these co-occurring conditions is as high as in clinical samples without ASD (Gadow et al., 2005). In fact, children with ASD are more likely to exhibit internalizing and externalizing

* Corresponding author at: Department of Psychiatry, Hospital Universitari Vall d'Hebron, Barcelona, Catalonia, Spain.

E-mail address: Jorge.lugo@vallhebron.cat (J. Lugo-Marín).

<https://doi.org/10.1016/j.cpr.2024.102410>

Received 30 March 2023; Received in revised form 14 January 2024; Accepted 19 February 2024

Available online 21 February 2024

0272-7358/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

symptoms compared to their non-autistic peers (Cibralic et al., 2019), which can negatively interfere with their adaptive functioning (Kaat et al., 2013).

Among internalizing symptoms, studies indicate that affective symptoms may be underdiagnosed or difficult to observe due to the predominance of the core autistic features (DeFilippis, 2018). In contrast, anxiety disorders, including social anxiety and phobic disorders, are highly prevalent in the ASD population and have been associated with greater intellectual ability, functional language, higher levels of stereotyped behaviors, and restricted interests (Baribeau et al., 2021; Sukhodolsky et al., 2008; White & Roberson-Nay, 2009). Regarding externalizing symptoms, aggression and hyperactivity symptoms occur more frequently in children with ASD than in individuals without ASD (Shea et al., 2018). Also, it has been found that approximately one in four children with ASD meet the diagnostic criteria for oppositional defiant disorder or conduct disorder (Kaat & Lecavalier, 2013).

An important factor consistently associated with both internalizing and externalizing symptoms in ASD is the challenge of effective emotion regulation (ER) (Cai et al., 2018), which has been linked to negative outcomes in daily activities for individuals with ASD, including worsened academic performance (Konstantareas & Stewart, 2006), increased problem behaviors, and reduced social relationships (Berkovits et al., 2017).

1.1. Definition of emotion regulation

Effective ER processes enable individuals to control the emotions they experience. This control encompasses the regulation of the type of emotions, the way in which they are expressed, as well as their intensity and duration (Gross, 1998). Following Gross's model, ER is a multi-component and dynamic process involving interactions between the individual and their environment. Through this process, the individuals evaluate, maintain, and modify their own emotions to achieve specific goals, using strategies that are socially accepted (Thompson, 1994). Gross's model defines five different groups of strategies or processes involved in ER, with four occurring before the emotion is generated (i.e., they are focused on the antecedents that give rise to the emotion) and the fifth taking place after the emotion is generated (i.e., involving strategies focused on the response that follows the emotion). These five groups of processes include: (1) Situation selection (e.g., strategies such as avoiding a situation); (2) Situation modification (e.g. taking action to eliminate a stressful situation); (3) Attentional deployment (e.g. distracting oneself or focusing on something else, whether pleasant or not); (4) Cognitive change (e.g. interpreting events in a more positive way); and (5) Response modulation (e.g. emotional suppression which involves inhibiting the expression of the emotion).

On the contrary, emotion dysregulation (ED) refers to a difficulty in managing and responding to emotional experiences in a manner that is socially acceptable or adaptive (Sáez-Suanes, García-Villamizar, & Del Pozo Armentia, 2023). ED can manifest as intense, rapidly escalating, and poorly regulated negative emotional reactions, such as feelings of anhedonia, sadness, and nervousness (Mazefsky et al., 2018; Sáez-Suanes, García-Villamizar, & Del Pozo Armentia, 2023). The issue lies not in the intensity of the emotional reaction itself, even if it is intense, but rather in the ineffective and inappropriate strategies employed by the person to achieve the optimal level of intensity in the specific situation (Tull & Aldao, 2015). A consistent pattern of ineffective or inappropriate regulation often hinders later developmental achievement, resulting in difficulties in forming and maintaining interpersonal relationships, communication problems, and coping with stress and problematic situations (Cicchetti et al., 1991).

1.1.1. Emotion regulation coping strategies

In addition to being categorized as either antecedent-focused or response-focused, various criteria for classifying ER strategies can be

found in the literature. For instance, these strategies can be classified as intrinsic or extrinsic, depending on whether the source of regulation is internal or external to the individual, respectively (Gross, 2013). This differentiation criterion can have implications for understanding ER in the context of development from infancy to adulthood. Extrinsic regulation is characteristic during the early years of life when the child requires the co-regulation from significant caregivers. As the child gains autonomy, intrinsic or autonomous ER abilities develop (Nuske et al., 2017; Paulus et al., 2021).

To assess their clinical relevance, ER strategies can be classified by considering the mental and physical health consequences that continued use of certain strategies might have for the individual. As such, it has been proposed that ER strategies can be categorized as adaptive or maladaptive (Aldao & Nolen-Hoeksema, 2012). For instance, emotional suppression (a response-focused strategy) appears to be less adaptive, as it directs all resources toward suppressing emotions and restricts interaction with the environment (Gross, 2001). In adaptive ER, the individual is aware of their emotions, knows their goals, and possesses the capacity to select and implement a strategy they deem appropriate to achieve their desired outcome (Gross & Jazaieri, 2014; Sheppes et al., 2015). Maladaptive regulation occurs when an individual fails to intentionally regulate an emotion, even when it would be beneficial, or when attempts to regulate emotions result in a mismatch between the chosen strategy and the situational context (Gross & Jazaieri, 2014). Additionally, factors like difficulty in identifying one's own emotions or challenges in effectively monitoring emotional changes after implementing a strategy (Cai et al., 2018) may play a role, as could be the case for children with ASD.

1.1.2. Emotion regulation association with age, sex and intellectual functioning

Several studies have shown an association between ER and age. For example, Sanchis-Sanchis et al. (2020) found that children and pre-adolescents in the 9–12 year group had lower scores in ER strategies than the 13–16 year group. Research has also shown that the ability to switch between cognitive and affective information, known as affective flexibility, varies with age. In a recent study, Samson et al. (2022) found that adolescents exhibited slower switching abilities compared to adults. This developmental trajectory suggests that as individuals age, they may become more adept at navigating the interplay between cognitive and emotional processes, enhancing their overall ER capabilities. Regarding the association of age and ED, Fenning et al. (2018) examined the predictors of ED in children with autism and found that ASD symptom severity was the strongest predictor of child ED. Furthermore, child age and parental scaffolding uniquely predicted child dysregulation in specific contexts. In the case of the ASD population there is a growing recognition of the need for proactive approaches to enhance ER in early childhood. A recent systematic review highlighted the importance of assessing ER outcomes within parent-mediated interventions for young autistic children, emphasizing the need for early and targeted interventions (Hendrix et al., 2022).

Sex differences in ER have also been observed. For example, in the previous mentioned study Samson et al. (2022) also found sex differences in ER in the context of cognitive-affective switching. While females tend to be faster switchers than males, they are slower when transitioning from cognitive to affective content compared to the reverse. This suggests sex-specific nuances in processing and regulating emotions, potentially influencing emotional responses and behaviors. Lischke et al. (2020) explored the relationship between interoception (the sense of the internal state of the body) and ER, differentiating between male and female individuals. The results showed that interoceptive accuracy was related to reappraisal in males but unrelated in females. While autism is more commonly diagnosed in males, emerging research suggests that females with autism may exhibit unique ER profiles. A study on the neurocognitive and behavioral development in young children with sex chromosome trisomy X highlighted the early

behavioral symptoms and neurocognitive vulnerabilities associated with ER (van Rijn et al., 2023). Another study emphasized the hormonal abnormalities in alexithymia, a trait characterized by difficulties in emotion recognition and regulation, suggesting potential sex-linked differences in ER in autism (Goerlich & Votinov, 2023).

Children with intellectual disabilities (ID) often exhibit deficits or delays in affective and cognitive Theory of Mind (ToM), closely linked to ER (Baurain & Nader-Grosbois, 2013; Thirion-Marissiaux & Nader-Grosbois, 2008). Jacobs and Nader-Grosbois (2020) have shown that enhanced ToM abilities, through training programs focusing on understanding mental states, including beliefs and emotions, can subsequently foster better ER and social adjustment in children with ID. Similarly, Te Brinke et al. (2021) found that adolescents with IDs are at risk for externalizing problems and tend to rely more on behavioral rather than cognitive regulation strategies. Additionally, ToM training led to a significant improvement in the understanding of cognitive mental states and the consequences of emotions in children with ID (Te Brinke et al., 2022). Intellectual functioning can also influence ER capacities in individuals with ASD. For example Sáez-Suanes, García-Villamizar, & Del Pozo Armentia, 2023 showed that Individuals with both ASD and intellectual disability (ID) often display significant depressive symptoms, although the relationship is complex. Their study showed that those with mild ID struggle with ER, leading to depressive symptoms.

1.2. ER/ED in ASD

The prevalence of ER problems in children with ASD has been estimated in around 60% (A. C. Samson et al., 2015). While difficulties in ER are observed in various mental health disorders (Paulus et al., 2021), particular attention has been focused on ASD due to the frequent occurrence of ER-related issues in children with ASD, similar to those seen in typically developing children with ER difficulties (Cibralic et al., 2019). ASD presents several risk factors that contribute to ER difficulties, including alexithymia, deficits in theory of mind, social skills, cognitive deficits, limited abstraction capacity and cognitive functioning, low inhibitory control, baseline hyperarousal, restricted interests, stereotyped behaviors, and inflexibility (Beck et al., 2020). It has been suggested that some mechanisms contributing to poor ER in individuals with ASD may be shared with other clinical populations. These mechanisms include dysfunctional arousal levels, varying degrees of negative and positive affect, and abnormalities in the amygdala and prefrontal cortex (White et al., 2014). In contrast, other mechanisms may be unique to ASD, encompassing differences in information processing/perception, cognitive factors like inflexibility, reduced goal-directed behavior, and heightened emotional disorganization (Mazefsky & White, 2014). ED in ASD has also been associated with difficulties in social and behavioral functioning and has been shown to be largely independent of IQ (Berkovits et al., 2017). Furthermore, it has been suggested that ED, particularly in the form of “emotional outbursts”, is related to a lower quality of family life (Nuske et al., 2017). Regarding coping ER strategies, research indicates that individuals with ASD encounter more ER difficulties and employ ER strategies less adaptively (Cai et al., 2018). Additionally, it has been observed that children with ASD exhibit greater intensity and duration of resignation, rely significantly more on avoidance and venting strategies, and employ fewer constructive strategies than their peers when faced with frustrating tasks (Jahromi et al., 2013).

1.2.1. Evaluation of ER/ED in ASD

The assessment of capacity for ER and ED relies on both subjective and objective methods. One of the most common subjective measures is parent/caregiver reports, often collected through scales, and self-reported measures for children and adolescents (Ayer et al., 2009; Mazefsky et al., 2018; Shields & Cicchetti, 1998). Additionally, subjective measures are used to assess self-report ER coping strategies (Eisenberg et al., 1994; Fabes et al., 1994; Garnefski et al., 2001). The

Emotion Dysregulation Inventory stands out, which is a scale that allows for the assessment of ED in children with ASD and groups items into the factors of Reactivity and Dysphoria (Mazefsky et al., 2018). Also, the Emotion Regulation Checklist, which assesses ER and provides scores for ER and lability/negativity (Shields & Cicchetti, 1998). Finally, among informant-based assessments, there is the Child Behavioral Checklist-Dysregulation Profile (CBCL-DP), which includes scores for the sub-scales of Anxiety-Depression, Attention, and Aggression to assess ED (Ayer et al., 2009). Among the observational measures proposed to evaluate ER/ED in individuals with ASD are structured experimental tasks in which specific situations are presented, and the child’s ED and practical ER coping strategies are coded based on an observational protocol (Calkins et al., 1999; Goldsmith & Rothbart, 1999; Grolnick et al., 1996). Furthermore, some physiological measures, such as respiratory sinus arrhythmia (RSA) and heart rate (HR), have garnered special attention in ER/ED evaluation (Beck et al., 2020). These measures are considered objective, as they provide insights into the parasympathetic activity of the autonomic nervous system, which has been reported to be correlated with ED and ER difficulties in individuals with ASD (Baker et al., 2022; Guy et al., 2014). Studies have highlighted an overactivation in children with ASD, characterized by lower RSA and higher HR (Bazelmans et al., 2019; Cheng et al., 2020; Sheinkopf et al., 2019; White et al., 2014).

1.2.2. Intervention in ER in ASD

Existing interventions to improve ER in children and adolescents with ASD encompass both pharmacological and non-pharmacological approaches. Among pharmacological interventions, aripiprazole and risperidone have demonstrated short-term efficacy in addressing irritability (D. Cohen et al., 2013), although they come with numerous side effects. It is important to consider these medications as part of a multimodal treatment plan since there is no specific pharmacological treatment designed to enhance ER skills (de Pablo et al., 2023; Fieiras et al., 2023). In the realm of non-pharmacological interventions, cognitive-behavioral approaches have shown promise and feasibility in improving ER in children and adolescents with ASD (Beck et al., 2020; Reyes et al., 2019; Rispoli et al., 2019). Early intervention to address ER difficulties in individuals with ASD is crucial for preventing the exacerbation of ASD symptoms, the deterioration of social skills, an increase in internalizing and externalizing symptoms, and a more significant impact on the family environment (Mazefsky & White, 2014).

1.3. Objective and review questions

Despite the fact that research on ER/ED in childhood and adolescents with ASD has been increasing in recent years, there is still considerable variability in the results found to date. Although several reviews on ER in ASD have been conducted (Beck et al., 2020; Cibralic et al., 2019; Reyes et al., 2019; Weiss et al., 2014), to date, a quantitative synthesis of the evidence on ER/ED in children and adolescents with ASD has not been conducted. For this reason, the present undertakes a systematic review and meta-analysis of the evidence on ER/ED in children and adolescents with ASD. The questions that guide this study are:

1. Are there significant differences between children and adolescents with ASD and those without ASD in subjective and observational measures of ER/ED?
2. Is there a significant association between ER/ED measures and ASD severity, intellectual quotient (IQ), social skills, and internalizing and externalizing symptoms?
3. Can demographic factors (age, sex) and cognitive factors (ID), as well as the study quality, significantly moderate the results found across the meta-analyses?
4. What is the efficacy of non-pharmacological ER interventions in children and adolescents with ASD in terms of ER, ED, social skills,

parent outcomes (e.g., quality of life), and internalizing and externalizing symptoms?

2. Methods

The present review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021) and was registered in PROSPERO under the ID CRD42023458703.

2.1. Search of studies

An electronic search was conducted across four databases (Pubmed, Psycinfo, Scopus, and Web of Science) from January 2000 to June 2023 and then updated in December 2023. The search syntax included the terms (“autism” OR “asd” OR “autism spectrum disorder” OR “asperger’s” OR “asperger’s syndrome” OR “autistic disorder” OR “aspergers” OR “autistic”) AND (emotion* regulation OR emotion* dysregulation). Results were filtered by publication type (journal articles), age group (0–18 years), and language (English). Additionally, a manual search was performed by reviewing the reference lists of potentially eligible articles, including published reviews related to the topic of this study. In cases where the necessary data could not be retrieved, we contacted the corresponding authors of the original studies to request inclusion in the meta-analysis. For more details on the electronic search please refer to Appendix A.

2.2. Inclusion and exclusion criteria

The selection criteria were: (1) diagnosis of ASD according to DSM/ICD criteria and/or confirmation with gold-standard diagnostic instruments (for intervention studies, a parent/caregiver diagnosis report was allowed); (2) child and adolescent population (ASD group with a mean age below 18 years); (3) evaluation studies that include subjective and/or observational measures of ER/ED and/or non-pharmacological intervention studies incorporating ER skills training session(s) within the intervention protocol; and (4) studies that provide means and standard deviations (or data allowing for the estimation of effect sizes) and/or correlations with the associated variables (ASD severity, intellectual functioning, social skills, internalizing and externalizing symptoms). For the ASD severity variable, we considered evaluation instruments that reported quantitative measures of ASD symptom severity, such as the Autism Diagnostic Observation Schedule. Regarding the intellectual functioning variable, we included measures of global IQ, such as the Wechsler’s Full-Scale Intelligence Quotient. For the social skills variable, we considered all evaluation measures that provided data on the social functioning of the participants, excluding those that specifically addressed difficulties in social communication associated with autism. As for the internalizing and externalizing symptomatology variables, we included measures of anxiety and depression for the former, and measures of anger, aggression and irritability for the latter.

The exclusion criteria were: (1) non-empirical studies (e.g., literature review); (2) studies with a sample size of fewer than 10 participants for evaluation studies and fewer than 5 participants for intervention studies; and (3) studies reported in languages other than English.

2.3. Data extraction and quality assessment

Two independent reviewers, D.R. and J.L.M., conducted reference screening based on title/abstract and full text. In case of disagreements, these were resolved through discussion between the two authors. A Microsoft Excel spreadsheet was created where the following variables were extracted: first author, publication year, number of participants, female-to-male ratio, and mean age in the ASD group, and mean age in the control group (if applicable). Furthermore, it was extracted the mean total IQ score and whether participants with ID were included/excluded

in the ASD group. For ER/ED evaluation studies, the following variables were also extracted: the instruments used for evaluating ER/ED and coping ER strategies (both subjective and observational measures), and instruments used to assess associated variables (ASD severity, intellectual functioning, social skills, internalizing and externalizing symptoms). In the case of intervention studies, the following measures were extracted: the type of control condition (e.g., waitlist), descriptive characteristics of the intervention (number of sessions, manualized intervention, parent involvement, and intervention format), and outcome variables (ER/ED, social skills, parent outcomes, internalizing and externalizing symptoms).

To assess the quality of the evaluation studies, the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines in its modified version (Limaye et al., 2018) was used. This approach assigns a quantitative score to observational studies (Cross-Sectional = 77 points; Cohort = 84 points; and Case-Control = 83), and provides a qualitative classification (Poor <50 points; Fair = 50–70; Good = 70–85; Excellent >85). For the assessment of intervention studies, the Council of Exceptional Children’s Evidence-based Practice Standards (CEC) (Cook et al., 2014). Altogether, this assessment comprises 28 Quality Indicators (QIs) that are evaluated in a binary manner, where a ‘yes’ score signifies that the criterion is fulfilled, and a ‘no’ score indicates that it is not fulfilled. Out of these, 18 QIs pertain to both group and single-case research designs, six are relevant exclusively to group designs, and four exclusively to single-case designs. A study was considered methodologically robust if it satisfied 80% or more of the pertinent QIs aligned with its specific research design.

2.4. Outcome measures

The outcome variables, relevant to the objectives of the present study, were recorded. To explore subjective measures, we considered self-reported and/or parent/caregiver-reported instruments assessing ER and/or ED in children and adolescents with ASD, along with their adaptive/maladaptive coping strategies. Laboratory tasks designed to potentially elicit ER/ED behaviors were considered as observational measures for this study’s purposes. When quantitative data on these measures were reported during the performance of different tasks, all tasks were recorded and included in the quantitative synthesis. To examine the relationship between ER/ED with ASD severity, intellectual functioning, social skills, and internalizing and externalizing symptoms, we considered instruments used in the original study methodology related to each construct.

2.5. Statistical analysis

All statistical analyses were performed using the Comprehensive Meta-Analysis 4 (Borenstein, 2022). In order to be included in a meta-analysis, a minimum of 10 effect sizes per outcome had to be identified. A random-effects model was chosen because it assumes that the true effect size could vary among studies and provides more generalizable results (Borenstein et al., 2010). Effect sizes were calculated as Hedges’s g and Pearson’s r correlation, along with their respective 95% confidence interval (CI). Cohen (2013) recommendations were followed for effect size interpretation of Hedges’s g : small (0.2), medium (0.5) and large (0.8); and for Pearson’s r : small (0.1), medium (0.3), and strong (0.5). In the Hedges’s g meta-analysis, a positive effect size indicates to higher scores on the specified ER measure in the ASD group as compared to the control group. Heterogeneity was assessed using the I^2 test (Higgins & Thompson, 2002), with thresholds of 25%, 50% and 75% indicating low, moderate and high heterogeneity, respectively. Publication bias was assessed by using a p -value obtained from Egger’s linear regression test of funnel plot asymmetry (Egger et al., 1997). Unless stated otherwise, a significance level of 0.05 was used.

In order to thoroughly investigate the influence of specific factors

related to ER/ED, as discussed in Section 1.1.2 of this paper, we conducted meta-regression analyses. The decision to employ meta-regression was driven by the observed significant heterogeneity among the included studies, indicating potential moderating effects of certain variables. Meta-regression analyses were performed using a random-effects model. We selected variables for this analysis based on two criteria: (1) they demonstrated significant effects in our preliminary analyses, and (2) there were >10 effect sizes available for that variable (or five studies in each category for categorical variables), ensuring a robust analysis. The following moderator variables were examined in separate models to avoid multicollinearity and to provide a clear interpretation of each factor's influence: Model 1: Mean age of the ASD group. This continuous variable was analyzed to determine if age variations within the ASD group influenced the observed effect sizes; Model 2: Proportion of female participants in the ASD group. We aimed to explore if sex distribution played a role in the observed outcomes; Model 3: Inclusion of participants with ID (IQ < 70) in the ASD group. This categorical variable was included to understand if the presence of ID among participants affected the results; Model 4: Quality assessment. This continuous variable was included to test whether variations in study quality could influence the observed effect sizes. The results of these meta-regression analyses, including regression coefficients and *p*-values, will be presented in the subsequent sections. Additionally, heterogeneity statistics (I^2) before and after the meta-regression will be

reported to demonstrate the extent to which these moderators explained the observed variability among studies (complete analysis in Appendix G).

3. Results

Fig. 1 shows the PRISMA flow diagram for the electronic search strategy. Initially, a total of 1076 studies were identified, with 652 remaining after duplicate removal. Six additional studies that fulfilled the inclusion criteria were found through the manual search. After finishing Title/Abstract screening, 304 studies were selected for full-text review. Finally, 55 separate published studies met criteria for inclusion in the quantitative synthesis of results (34 evaluation studies and 21 intervention studies). Regarding evaluation studies, the mean age of the ASD group ranged from 26.4 months to 15.78 years and the mean total IQ score ranged from 80.02 to 110.48, with only nine studies (26%) reporting the inclusion of participants with below-average IQ scores. For the intervention studies, the mean age of the ASD group ranged from 53.43 months to 18 years and the mean total IQ score ranged from 87.45 to 109.21, with only seven studies (33%) reporting the inclusion of participants with below-average IQ scores. The proportions of female participants in the ASD group ranged from 0% to 37% for the evaluation studies and 7% to 40% for intervention studies. Appendix B includes a qualitative synthesis of studies included in the meta-analysis.

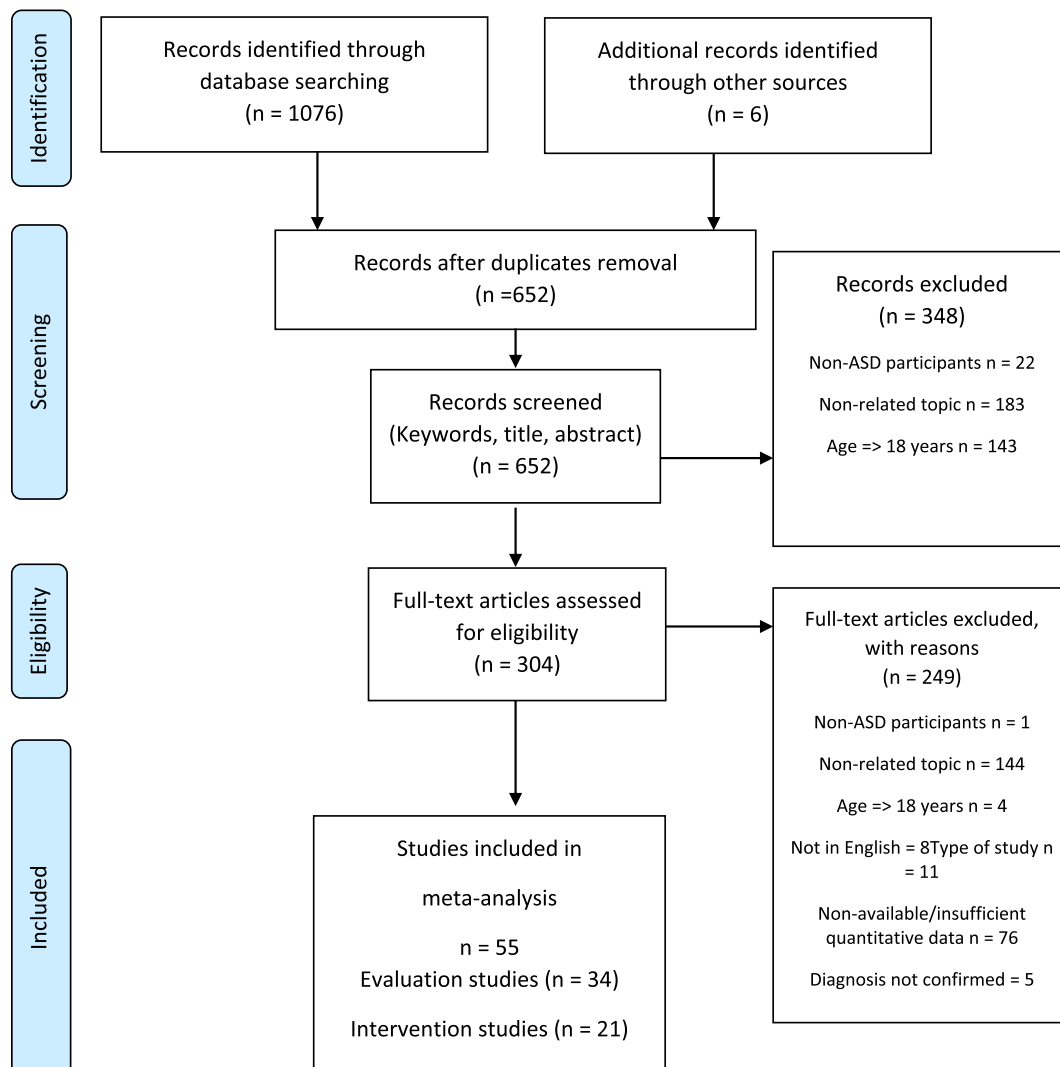


Fig. 1. PRISMA flow diagram.

3.1. Quality assessment of included studies

In evaluation studies, quality assessment ranged from “poor” in 11 studies to “fair” in 22 studies, with one study rated as “good” (see Appendix C). The least commonly reported items included relevant dates of recruitment and data collection, required power calculations and statistical significance, subgroup analysis, recruitment flow-diagram considering numbers of eligible individuals and reasons for non-participation, number of participants with missing data, and reporting estimates with precision (confidence interval) (see Appendix D). In the context of intervention studies, 12 studies achieved a compliance rate of 80% or higher with the Quality Indicators (QIs). Frequently, these studies fell short in terms of meeting specific criteria, such as evaluating adherence and implementation fidelity to the intervention, documenting a minimum of three assessment timepoints (e.g., pre-intervention, post-intervention, and follow-up), and employing graphs to visually represent the results.

3.2. Meta-analyses of subjective/observation ER/ED measures

The results of each meta-analysis are summarized in Table 1. The meta-analysis of subjective/observation ER measures included a total of 10 studies that collectively provided 11 effect sizes. These studies involved a sample of 220 individuals diagnosed with ASD and 189 control participants. The results show a significant large effect (Hedges' $g = -1.31$, 95% CI $[-1.79, -0.83]$, $p < .001$), indicating that the control group had higher ER skills compared to the ASD group. The meta-analysis of subjective/observation ED measures also revealed significant large effects for studies evaluating ED (Hedges' $g = -1.69$, 95% CI $[-2.03, -1.36]$, $p < .001$), including 1244 individuals diagnosed with ASD and 2289 control participants, and finding greater ED impairment in the ASD group. Heterogeneity was significant in all cases ($p < .001$). The publication bias analysis did not reveal significant results in any of the cases. Meta-regression analyses did not yield significant results in any instance.

3.3. Meta-analyses of ER adaptive/maladaptive strategies

In the meta-analysis of ER strategies, twelve studies (with 33 effect sizes) and eight studies (with 14 effect sizes) were included for adaptive and maladaptive ER strategies, respectively. The total samples consisted of 541 and 299 individuals with ASD for adaptive ER strategies, and 527 and 346 individuals without ASD for maladaptive ER strategies. Significant small effect sizes were found (Adaptive: Hedges' $g = -0.18$, 95% CI $[-0.35, -0.02]$, $p = .03$; Maladaptive: Hedges' $g = 0.47$, 95% CI $[0.24, 0.7]$, $p < .001$), indicating that the ASD group exhibited more maladaptive ER strategies and fewer adaptive ER strategies compared to the control group. Heterogeneity was significant in all cases ($p < .001$). The publication bias analysis revealed significant effect in the case of maladaptive ER strategies (Egger's $r = 2.85$, $p = .01$). Meta-regression analyses showed significant effects related to study quality for the adaptive ER strategies ($R^2 = 0.1$, $p = .03$), with higher quality studies predicting smaller differences between ASD and control groups.

Table 1

Synthesis results of the meta-analyses for evaluation of emotion regulation in ASD.

Emotion regulation (<i>k</i> effect sizes)	ASD (n)	Control (n)	Hedges' <i>s</i> <i>g</i> (95%, CI)	Prediction Interval	Test for effect (random model)		Heterogeneity	
					<i>z</i>	<i>p</i>	<i>p</i>	<i>I</i> ²
Subjective/Observation ER measures								
Emotion regulation (11)	220	189	-1.31 (-1.79, -0.83)	-3.1, 0.49	-5.34	<0.001	<0.001	89.07
Emotion dysregulation (12)	1244	2289	-1.69 (-2.03, -1.36)	-2.99, -0.4	-9.83	<0.001	<0.001	95.65
Adaptive ER strategies								
Overall (33)	541	527	-0.18 (-0.35, -0.02)	-1, 0.63	-2.21	0.03	<0.001	71.73
Maladaptive ER strategies								
Overall (14)	299	346	0.47 (0.24, 0.7)	-0.33, 1.27	4.05	<0.001	<0.001	69.66

3.4. Correlation meta-analyses

Tables 2 shows a synthesis of the results of each meta-analysis. Correlation between ED measures and ASD severity was conducted using 16 effect sizes from 7 studies, involving 430 individuals diagnosed with ASD. A significant small effect was found (Pearson's $r = 0.19$, 95% CI $[0.06, 0.32]$, $p < .001$), indicating that individuals with more severe ASD presentations had greater ED. Heterogeneity was significant ($p < .001$) and the publication bias test did not reveal significant results. Meta-regression analyses showed significant effects for the female proportion of participants with ASD ($R^2 = 0.18$, $p = .03$), suggesting that studies with a higher proportion of female participants with ASD showed an increased association between ED and ASD severity.

The association of subjective/observation ER measures with social skills was evaluated using 11 effect sizes extracted from 6 studies involving 263 individuals diagnosed with ASD. A significant medium effect was found (Pearson's $r = 0.46$, 95% CI $[0.13, 0.69]$, $p = .01$), indicating individuals with better social skills tend to exhibit better ER skills. Heterogeneity was significant ($p < .001$). The publication bias analysis did not reveal significant results. No meta-regression analyses found significant result.

The association of adaptive and maladaptive ER strategies with internalizing symptoms was studied using 17 and 25 effect sizes for adaptive and maladaptive ER strategies, respectively. This analysis incorporated data from four studies, comprising a collective sample of 351 individuals diagnosed with ASD. Both correlation meta-analyses yielded significant medium effects (Adaptive: Pearson's $r = -0.29$, 95% CI $[-0.35, -0.22]$, $p < .001$; Maladaptive: Pearson's $r = 0.28$, 95% CI $[0.17, 0.39]$, $p < .001$), indicating adaptive strategies being negatively related, and maladaptive strategies being positively related with internalizing symptoms. Heterogeneity was significant in the maladaptive meta-analysis ($p < .001$). The publication bias analysis revealed significant results for the adaptive ER strategies (Egger's $r = 2.22$, $p = .04$). No meta-regression analyses found significant result.

Not enough number of effect sizes were identified regarding the association between ER and ASD severity (8), as well as between ED and social skills (1). Additionally, insufficient research was available on the relationship between ER/ED measures and both IQ (7) and externalizing symptomatology (6). Consequently, a meta-analysis on these outcomes could not be conducted.

3.5. Meta-analyses of intervention studies

Table 3 presents a synthesis of the results from each meta-analysis. In the within-group studies, we incorporated 9 studies that reported 17 effect sizes for ER, 8 studies with 11 effect sizes for ED, 8 studies with 14 effect sizes for internalizing symptoms, 5 studies contributing 20 effect sizes for parent outcomes, and 5 studies providing 15 effect sizes for social skills. All outcomes reached statistical significance in the meta-analysis (ER: Hedges' $g = 0.5$, 95% CI $[0.32, 0.68]$, $p < .001$; ED: Hedges' $g = 0.66$, 95% CI $[0.48, 0.84]$, $p < .001$; Internalizing symptoms: Hedges' $g = 0.58$, 95% CI $[0.41, 0.75]$, $p < .001$; Parent outcomes: Hedges' $g = 0.23$, 95% CI $[0.11, 0.34]$, $p < .001$; and Social skills:

Table 2

Synthesis results of the meta-analyses for evaluation of emotion regulation association with relevant variables in ASD.

Emotion regulation (<i>k</i> effect sizes)	ASD (n)	Correlation (95%, CI)	Prediction Interval	Test for effect (random model)		Heterogeneity	
				<i>z</i>	<i>p</i>	<i>p</i>	<i>I</i> ²
Subjective/Observation ER measures							
Emotion dysregulation – ASD severity (16)	430	0.19 (0.06, 0.30)	–0.29, 0.59	2.97	<0.0010	<0.001	76.31
Emotion regulation - Social skills (11)	263	0.46 (0.13, 0.69)	–0.70, 0.95	2.71	.01	<0.001	92.63
Adaptive ER strategies							
Internalizing (17)	351	–0.29 (–0.35, –0.22)	–0.39, –0.18	–8.31	<0.001	0.36	8.23
Maladaptive ER strategies							
Internalizing (25)	351	0.28 (0.17, 0.39)	–0.22, 0.67	4.82	<0.001	<0.001	72.64

Table 3

Synthesis results of the meta-analyses for intervention in emotion regulation in ASD.

Outcomes (<i>k</i> effect sizes)	ASD (n)	Control (n)	Hedges's <i>g</i> (95%, CI)	Prediction Interval	Test for effect (random model)		Heterogeneity	
					<i>z</i>	<i>p</i>	<i>p</i>	<i>I</i> ²
Within-group (Pre-Post)								
Emotion regulation (17)	220	-	0.5 (0.32, 0.68)	–0.15, 1.15	5.39	<0.001	<0.001	61.39
Emotion dysregulation (11)	181	-	0.66 (0.48, 0.84)	0.23, 1.09	7.29	<0.001	0.13	34.11
Internalizing symptoms (14)	155	-	0.58 (0.41, 0.75)	0.13, 1.02	6.59	<0.001	0.12	32.02
Parent outcomes (20)	119	-	0.23 (0.11, 0.34)	0.1, 0.35	3.97	<0.001	0.45	0.75
Social skills (15)	231	-	0.55 (0.31, 0.79)	–0.39, 1.48	4.47	<0.001	<0.001	78.17
Between-group (Post)								
Emotion regulation (16)	188	222	0.86 (0.37, 1.35)	–1.25, 2.97	3.41	<0.001	<0.001	91.87
Parent outcomes (12)	74	67	0.54 (0.28, 0.8)	–0.23, 1.31	4.06	<0.001	0.02	50.99

Hedges' $g = 0.55$, 95% CI [0.39, 1.31], $p < .001$), suggesting improvement after the intervention. Heterogeneity analysis was significant for Emotion regulation ($p < .001$) and for Social skills ($p < .001$). Publication analysis revealed significant results for Emotion dysregulation (Egger's $r = 2.83$, $p = .01$), Internalizing symptoms (Egger's $r = 6.13$, $p < .001$) and Parent outcomes (Egger's $r = 2.79$, $p = .01$). Insufficient studies were found that reported measures for externalizing symptomatology, and as a result, it was not possible to carry out a meta-analysis on this outcome.

In the between-group meta-analysis, we included 7 between-group studies that presented 16 effect sizes for ER, along with 4 between-group studies that contributed 12 effect sizes for parent outcomes. ER and Parent outcomes yielded significant large and medium effect sizes, respectively (ER: Hedges' $g = 0.86$, 95% CI [0.37, 1.35], $p < .001$; Parent outcomes: Hedges' $g = 0.54$, 95% CI [0.28, 0.8], $p < .001$), suggesting greater improvement in the ASD group compared to the control group. Heterogeneity was significant ($p < .001$) for ER studies. Publication bias revealed significant results for both ER (Egger's $r = 2.29$, $p = .04$) and Parent outcomes (Egger's $r = 6.18$, $p < .001$). Insufficient effect sizes were found that reported measures related to ED (7), social skills (6), internalizing (5) and externalizing (4) symptomatology, and as a result, it was not possible to conduct a meta-analysis on these outcomes.

For a more comprehensive presentation of the meta-analysis results, please refer to Appendices E (Forest plots), F (Analyses of publication bias and funnel plots) and G (Meta-regressions).

4. Discussion

To the best of our knowledge, this is the first meta-analysis that synthesizes the evidence on evaluation and intervention studies of ER/ED in children and adolescents with ASD. The results showed poorer ER skills as well as greater ED impairment in children and adolescents with ASD compared to non-autistic controls evaluated with both subjective and observational measures. In addition, the results highlight a significant association between difficulties in ER/ED with the severity of the ASD, social skills and internalizing symptoms. Additionally, variables such as sex or the study quality could predict scores on some measures

associated to ER and ED. In regards of intervention, the quantitative synthesis found improvement after delivery of non-pharmacological ER intervention for several outcomes, including ER, ED, social skills, internalizing symptoms and parent outcomes. Taken together, the results have great clinical value and could guide both the evaluation and intervention of ER/ED in this population.

4.1. Question 1. Differences between ASD and non-ASD children and adolescents in ER/ED subjective/observation measures

In the context of differences between ASD and non-ASD individuals in ER/ED assessed through subjective/observational methods, our results support the hypothesis of greater difficulties in ER in children and adolescents with ASD compared to their typically developing peers. Following the model of coping ER strategies proposed by Connor-Smith et al. (Connor-Smith et al., 2000), participants with ASD exhibited less use of adaptive strategies and greater reliance on maladaptive ER strategies compared to the control participants. However, due to the high heterogeneity in the methodologies used to assess and report coping ER strategies, a study of the frequency of each individual coping ER strategy in participants with ASD could not be conducted. Future studies should explore the most frequently used adaptive ER coping strategies in children and adolescents with ASD. This research will contribute to a better understanding of the preferred coping mechanisms that should be incorporated into an ER intervention program.

It is important to highlight that in all the studies included in the ER meta-analysis, except for one (López-Pérez et al., 2018), data were primarily derived from reports provided by parents or caregivers of children and adolescents with ASD. Similarly, most recent studies that examined the use of coping strategies for ER relied on observational approaches (Costa et al., 2019a; Hirschler-Guttenberg et al., 2015; Nuske et al., 2017; A. C. Samson et al., 2015; Zantinge et al., 2017), whereas earlier investigations assessed these strategies through self-report measures administered to the autistic individuals themselves (Mazefsky et al., 2014; Pouw et al., 2013; Rieffe et al., 2014, 2011). In this context, none of the studies integrated both approaches into their research methodologies. In future research, it is advisable to

contemplate the incorporation of both self-report and observational measures to explore convergence. Moreover, it is of utmost importance to include self-report evaluations for individuals with ASD when assessing ER and ED, as this can provide valuable insights into their personal experiences while navigating ER/ED challenges.

4.2. Question 2. Association with clinical variables

Regarding the results concerning the association between ER/ED and clinical variables, significant findings emerged in connection with autism severity, social skills and internalizing symptoms.

Regarding the severity of ASD, findings suggest that greater difficulties in ED were evident as the severity of autistic symptoms increased, albeit with a small effect size. One potential explanation for this observation is the variability in the methodologies employed to assess the severity of ASD. Notably, studies utilizing parent-reported methodologies tended to yield stronger correlations between ASD severity and ED challenges (Berkovits et al., 2017; Butterworth et al., 2014; Gormley et al., 2022; A. C. Samson et al., 2014; Yager & Iarocci, 2013), whereas those employing observational methods revealed weaker correlations between ASD severity and parent-reported ED difficulties (Baker et al., 2022; Berkovits et al., 2017; Butterworth et al., 2014; Lin et al., 2020; Ni et al., 2020, 2018). To comprehensively investigate the connection between ASD severity and difficulties in ED, future research should encompass a range of methodologies for assessing ASD symptomatology.

In examining the relationship between ER and social skills, our findings consistently revealed a robust positive association, indicating that an improvement in the social skills of children and adolescents with ASD was accompanied by enhanced ER skills. It is noteworthy that certain studies incorporated composite measures that blended ER and social skills (Butterworth et al., 2014), potentially introducing an artificial inflation of the correlation between these variables. However, this favorable association was consistently detected across all studies incorporated in this meta-analysis (Berkovits et al., 2017; Butterworth et al., 2014; Guy et al., 2014; Jahromi et al., 2013, 2021; Reyes et al., 2020), underscoring the robustness and reliability of this relationship. Consequently, our results suggest the potential to enhance social skills in children and adolescents with ASD through targeted therapeutic interventions addressing their ER challenges. Intervention programs targeting social skills in children and adolescents with ASD should take into account this salient association when designing their intervention strategies.

The investigation into the ER strategies, the findings consistently revealed a near-to-moderate association between internalizing symptomatology and the utilization of ER strategies. Specifically, there was a positive association observed for maladaptive ER strategies and a negative association for adaptive ER strategies. It is important to note that the studies included in this meta-analysis exclusively employed self-report measures to assess ER strategies in their research methodologies, whereas the sources of informant for internalizing symptomatology were balanced between self-report and parent-report. Of interest, a post-hoc sensitivity analysis revealed a stronger correlation in those studies where both variables were self-reported by the child/adolescent with ASD, compared to when the variable of internalizing symptomatology was reported by the family (see Appendix H). This aligns with the expectation that internalizing symptomatology, by definition, is better perceived subjectively by the individual experiencing it. This holds significance in the assessment of this symptomatology in children and adolescents with ASD, which is often prone to underestimation due to challenges in insight. Typically, such assessments rely on reports from external informants, who more frequently identify externalizing symptoms while underestimating the presence of internalizing symptoms. Lastly, as discussed in the preceding section, the abundance of described strategies and the limited number of identified studies precluded an in-depth analysis at the single strategy level to ascertain which ER strategies exhibit the strongest correlation with internalizing

symptomatology. The implementation of a standardized and uniform assessment protocol for these strategies will facilitate an examination of those that may serve as protective factors or potential contributors to the development of internalizing symptomatology in children and adolescents with ASD.

In our study, we incorporated intellectual functioning and externalizing symptomatology as measures of association. However, we identified a shortage of studies that reported both variables. Regarding intellectual functioning, only four studies (Baker et al., 2022; Berkovits et al., 2017; Conner et al., 2022; A. C. Samson et al., 2014), contributing six effect sizes, met the criteria for inclusion in the meta-analysis. In contrast, only one study (Reyes et al., 2020) was identified that reported correlation values between externalizing symptomatology and challenges in ER. Additionally, although it was not a specific focus of this study, the paucity of identified studies investigating the relationship between ER and ADHD in children and adolescents with ASD is noteworthy. In our current review, only one study explored the connection between a parent-report measure of ER and a hyperactivity/inattention scale (Reyes et al., 2020). Furthermore, ADHD was neither considered within inclusion/exclusion criteria nor included as a covariate in any of the identified studies. Given the well-established association between ER difficulties and individuals diagnosed with ADHD (Beheshti et al., 2020; Graziano & Garcia, 2016), it is imperative to incorporate this variable when conducting ER research within the ASD population. Similarly, only a limited number of studies have investigated the link between ER and executive functioning in the studies reviewed (Bazelmans et al., 2019; Guy et al., 2014; Jahromi et al., 2013; Zantinge et al., 2017). Considering the acknowledged role of executive skills in the processes related to behavior and emotion regulation (Morawetz et al., 2017), one might anticipate an intrinsic relationship between ER and executive functions in this population. Future research endeavors should address these gaps and explore the connections of these relevant variables with difficulties in emotion regulation within this population.

4.3. Question 3. Meta-regression analyses

The meta-regression analysis returned significant results for some of the included moderators.

4.3.1. Age

While not statistically significant, the findings in our study suggest an increase in difficulties related to ER and ED as individuals traverse their developmental stages. This outcome runs contrary to the anticipated trend, as it is typically observed that ER difficulties are more prevalent during childhood and tend to ameliorate during adolescence in the general population (Sanchis-Sanchis et al., 2020). A recent meta-analysis that synthesized longitudinal studies involving individuals with ASD reported a decrease in the frequency of challenging behaviors, which are closely tied to ER skills, in follow-up assessments (Adams et al., 2023). It is worth noting, however, that the authors acknowledged methodological limitations, including the use of measures of central tendency rather than measures of behavior frequency and severity. In our study, one potential explanation for this observed pattern is associated with the distinct demands of each developmental stage. Reports indicate that as children with ASD progress in their development, the inherent challenges of autism become more pronounced. This phenomenon is particularly conspicuous in cases involving individuals with profiles characterized by lower levels of support needs, where difficulties often remain unnoticed, thereby placing these individuals at a heightened risk of developing mental health-related issues (Salazar et al., 2015). Future research endeavors aimed at investigating ER should incorporate longitudinal methodologies spanning childhood and adolescence while taking into consideration the severity level of ASD. Such an approach will contribute to a deeper understanding of this phenomenon.

4.3.2. Sex

In our study, we observed that a higher representation of females among participants with ASD seems to amplify the relationship between ASD severity and ED challenges. This observation aligns with existing evidence suggesting that females diagnosed with ASD often present more severe forms of the condition compared to their male counterparts (Dworzynski et al., 2012). In this context, it is conceivable that the increased association may be artificially enhanced due to the inclusion of individuals with more severe forms of autism in the female ASD group, potentially masking the genuine link between ASD severity and ED difficulties. One limitation identified in the course of this review is the shortage of studies that provide separate reporting data by sex. Future investigations assessing ED in children and adolescents with ASD should include sex-segregated data to facilitate a more comprehensive understanding of how sex contributes to the relationship between ASD severity and ED difficulties.

4.3.3. Intellectual disability

Only nine studies (Baker et al., 2022; Berkovits et al., 2017; Butterworth et al., 2014; Chiu et al., 2023; Conner et al., 2020, 2021; Costa et al., 2019b; DeLucia et al., 2021; A. C. Samson et al., 2014) reported including participants with ID in the ASD group, while 12 studies did not report their inclusion (Guy et al., 2014; Hirschler-Guttenberg et al., 2015; Jahromi et al., 2013, 2021, 2012; Konstantareas & Stewart, 2006; Nuske et al., 2017; Reyes et al., 2020; Rieffe et al., 2014, 2011; Yager & Iarocci, 2013; Zantinge et al., 2017), and one study included a sample that was too young to assess intellectual capacity (Day et al., 2023). As a result, meta-regression analysis could only be conducted in a limited number of cases, yielding non-significant results each time. Future studies should strive to increase the representation of individuals with ASD and associated ID and explicitly report their inclusion/exclusion within the study sample.

4.3.4. Study quality

The quality of the included studies had a significant impact on the meta-regression analysis of adaptive ER strategies, indicating a reduction in differences between the ASD and control groups in their usage. This finding should be considered in light of a limitation identified in the analysis of study quality. As shown in Appendix C, a strong correlation was found between the study quality and the year of publication, with more recent studies exhibiting higher reporting quality. This suggests a potential confounding effect, as newer studies may report with higher quality due to better alignment with the criteria used to assess study quality (Limaye et al., 2018). No other meta-regression analysis yielded significant results for the study quality moderator.

4.4. Question 4. Efficacy of non-pharmacological ER intervention

The meta-analysis of non-pharmacological interventions for ER produced significant results across all assessed outcomes, suggesting improvements following the interventions. Effect sizes were of moderate magnitude for ER, ED, internalizing symptoms, and social skills, whereas for outcomes related to parents, the effect size was small. The variance in effect sizes could be explained by the range of subcategories encompassed within the broader classification of “parent outcomes”. Regrettably, due to the limited available data, conducting a meta-analysis for externalizing symptomatology was not feasible, as only 5 studies that provided 8 effect sizes for this outcome were identified.

In addition, the meta-analysis on between-group studies yielded large and medium effect sizes for ER and parent outcomes, respectively. This result is of particular interest, as the majority of interventions included parental involvement during the sessions, thereby potentially enhancing collateral variables related not only to parental stress but also to parents’ own emotions management. Unfortunately, there were insufficient studies available to perform meta-analyses for social skills (3 studies, 6 effect sizes), internalizing symptomatology (4 studies, 5 effect

sizes), and externalizing symptomatology (3 studies, 4 effect sizes).

It’s worth mentioning that only a limited number of studies documented the inclusion of participants with intellectual functioning falling below the normative range (Beck et al., 2022; Einfeld et al., 2018; Mahler et al., 2022; Scarpa & Reyes, 2011; Shaffer et al., 2023, 2019; Tse, 2020), and the majority of the participant samples consisted of males.

4.5. Limitations

While this study possesses notable strengths, it is important to acknowledge certain limitations. First, the heterogeneity analyses showed significant results, compromising the generalization of the results. The development of a standardized ER/ED assessment protocol which can be replicated is recommended in order to increase homogeneity through research designs. The publication bias analysis revealed significant results for differences in the utilization of maladaptive ER strategies and the relationship between adaptive ER strategies and internalizing symptomatology. Additionally, publication bias analyses showed significance across almost all cases, with the exception of the social skills variable. This pattern could be attributed to the limited number of included studies, leading to an underrepresentation of published studies reporting negative results. Another limitation affecting external validity is the underrepresentation of females among ASD participants. There is evidence of sex influencing the manifestation of the core autism symptomatology (Wood-Downie et al., 2021), which may also be reflected in differences in ER skills. Also, medication and co-occurring disorders could potentially influence ER/ED (Jahromi et al., 2009; McRae et al., 2014). However, only few studies reported the frequencies of psychotropic medication use and co-occurring disorders in the ASD group, preventing the possibility of conducting a moderator analysis. Finally, our study exclusively incorporated subjective and observational measures. While previous research has established the inclusion of physiological measures such as respiratory sinus arrhythmia and heart rate variability as objective ER indicators (Agako et al., 2022; Beck et al., 2020), and there is evidence of their relationship with subjective ER/ED measures in ASD (Baker et al., 2022; Guy et al., 2014), the lack of specificity of these physiological measures in assessing ER might hinder their classification as purely objective ER measures. This underscores the need for the development of more precise and objective measures specifically design to capture the challenges inherent in navigating ER processes among children and adolescents with ASD.

The authors would like to highlight a prominent challenge in the field of ER research that is the difficulty in differentiating between ER, ED, and maladaptive regulation within measurement frameworks. To address this, it is essential to explore objective measures that can accurately distinguish ER in everyday scenarios from instances of dysregulation. Similarly, Lavender et al. (2017) highlight a significant shortcoming in current ER measures: their emphasis on dispositional traits and general tendencies at the expense of situational variability in ER strategies. This oversight results in a partial portrayal of ER, neglecting the dynamic manner in which individuals adapt their regulation strategies to specific situational challenges and environmental contexts. The study concluded the necessity for state-based ER measures that can provide real-time, context-specific evaluations, thereby offering a more thorough understanding of the intricacies and dynamics of ER in everyday life. Springstein & English, 2023 have notably addressed this challenge, proposing an innovative approach that emphasizes the importance of acknowledging both individual differences and situational variables in emotion goals and regulation strategies. Their method advocates for a more detailed and inclusive assessment of ER success, moving beyond traditional measures that solely focus on the increase of positive affect and reduction of negative affect. This approach is particularly relevant in complex scenarios such as those faced by people with ASD, where situational and personal factors play a key role in ER processes. Continuing in this line of research could also help to broaden

understanding of how ER differs in ASD compared to other clinical conditions, especially in terms of identifying and employing regulation goals and strategies.

4.6. Conclusions

The results of this meta-analysis point to a higher degree of ER/ED difficulties in children and adolescents with ASD when compared to non-autistic controls, as assessed through both subjective and observational measures. Moreover, significant associations were identified between ED and the severity of ASD, as well as poorer social skills and increased internalizing symptomatology with ER. Factors such as sex and study quality may moderate the results, impacting both subjective and observational measures of ER/ED. Additionally, non-pharmacological interventions, which incorporate ER training components, hold promise for improving clinically relevant variables, especially social skills.

Overall, the evaluation and treatment of ER skills and ED difficulties in clinical practice can offer significant benefits to children and adolescents with ASD. These findings underscore the importance of assessing and addressing both in this specific population. Future research should consider variables of clinical interest, such as the presence of ADHD and other co-occurring difficulties (e.g., externalizing symptomatology), and should report on the inclusion of underrepresented groups, including females and individuals with ID. Importantly, further longitudinal research is needed to explore the long-term impact of ER/ED difficulties on development, shedding light on their role in the core symptoms of ASD, as well as their influence on the development of social skills and internalizing/externalizing symptoms.

Role of funding sources

No specific funding was received for this study.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to check grammar and language. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

All authors declare that they have no conflicts of interest.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cpr.2024.102410>.

References

- Adams, D., Dargue, N., & Paynter, J. (2023). Longitudinal studies of challenging behaviours in autistic children and adults: A systematic review and meta-analysis. *Clinical Psychology Review*, 102320.
- Agako, A., Ballester, P., Stead, V., McCabe, R. E., & Green, S. M. (2022). Measures of emotion dysregulation: A narrative review. *Canadian Psychology/Psychologie canadienne*, 63(3), 376.
- Aldao, A., & Nolen-Hoeksema, S. (2012). When are adaptive strategies most predictive of psychopathology? *Journal of Abnormal Psychology*, 121(1), 276.
- American Psychiatric Association, D., & Association, A. P. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5 (Vol. 5, Issue 5)*. Washington, DC: American psychiatric association.
- Ayer, L., Althoff, R., Ivanova, M., Rettew, D., Waxler, E., Sulman, J., & Hudziak, J. (2009). Child behavior checklist juvenile bipolar disorder (CBCL-JBD) and CBCL posttraumatic stress problems (CBCL-PTSP) scales are measures of a single dysregulatory syndrome. *Journal of Child Psychology and Psychiatry*, 50(10), 1291–1300.
- Baker, J. K., Fenning, R. M., Erath, S. A., & Fabian, S. (2022). Parasympathetic withdrawal indexes risk for emotion dysregulation in children with autism spectrum disorder. *Autism Research*, 15(11), 2064–2068.
- Baribeau, D. A., Vigod, S., Pullenayegum, E., Kerns, C. M., Mirenda, P., Smith, I. M., ... Zwaigenbaum, L. (2021). Co-occurring trajectories of anxiety and insistence on sameness behaviour in autism spectrum disorder. *The British Journal of Psychiatry*, 218(1), 20–27.
- Baurain, C., & Nader-Grosbois, N. (2013). Theory of mind, socio-emotional problem-solving, socio-emotional regulation in children with intellectual disability and in typically developing children. *Journal of Autism and Developmental Disorders*, 43, 1080–1097.
- Bazelmans, T., Jones, E. J. H., Ghods, S., Corrigan, S., Toth, K., Charman, T., & Webb, S. J. (2019). Heart rate mean and variability as a biomarker for phenotypic variation in preschoolers with autism spectrum disorder. *Autism Research*, 12(1), 39–52.
- Beck, K. B., Conner, C. M., Breitenfeldt, K. E., Northrup, J. B., White, S. W., & Mazefsky, C. A. (2020). Assessment and treatment of emotion regulation impairment in autism spectrum disorder across the life span: Current state of the science and future directions. *Child and Adolescent Psychiatric Clinics of North America*, 29(3), 527–542.
- Beck, K. B., Northrup, J. B., Breitenfeldt, K. E., Porton, S., Day, T. N., MacKenzie, K. T., ... Mazefsky, C. A. (2022). Stakeholder informed development of the emotion awareness and skills enhancement team-based program (EASE-teams). *Autism*, 26(3), 586–600.
- Beheshti, A., Chavanon, M.-L., & Christiansen, H. (2020). Emotion dysregulation in adults with attention deficit hyperactivity disorder: A meta-analysis. *BMC Psychiatry*, 20(1), 1–11.
- Berkovits, L., Eisenhower, A., & Blacher, J. (2017). Emotion regulation in young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 47, 68–79.
- Borenstein, M. (2022). Comprehensive meta-analysis software. *Systematic Reviews in Health Research: Meta-analysis in Context*, 535–548.
- Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2010). A basic introduction to fixed-effect and random-effects models for meta-analysis. *Research Synthesis Methods*, 1(2), 97–111.
- Butterworth, T. W., Hodge, M. A. R., Sofronoff, K., Beaumont, R., Gray, K. M., Roberts, J., ... Taffe, J. R. (2014). Validation of the emotion regulation and social skills questionnaire for young people with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 44, 1535–1545.
- Cai, R. Y., Richdale, A. L., Uljarević, M., Dissanayake, C., & Samson, A. C. (2018). Emotion regulation in autism spectrum disorder: Where we are and where we need to go. *Autism Research*, 11(7), 962–978.
- Calkins, S. D., Gill, K. L., Johnson, M. C., & Smith, C. L. (1999). Emotional reactivity and emotional regulation strategies as predictors of social behavior with peers during toddlerhood. *Social Development*, 8(3), 310–334.
- Cheng, Y.-C., Huang, Y.-C., & Huang, W.-L. (2020). Heart rate variability in individuals with autism spectrum disorders: A meta-analysis. *Neuroscience & Biobehavioral Reviews*, 118, 463–471.
- Chiu, H. T., Ip, I. N., Ching, F. N. Y., Wong, B. P.-H., Lui, W.-H., Tse, C.-S., & Wong, S. W. H. (2023). Resting heart rate variability and emotion dysregulation in adolescents with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, 1–12.
- Cibralic, S., Kohlhoff, J., Wallace, N., McMahon, C., & Eapen, V. (2019). A systematic review of emotion regulation in children with autism Spectrum disorder. *Research in Autism Spectrum Disorders*, 68, 101422.
- Cicchetti, D., Ganiban, J., & Barnett, D. (1991). *Contributions from the study of high-risk populations to understanding the development of emotion regulation*.
- Cohen, D., Raffin, M., Canitano, R., Bodeau, N., Bonnot, O., Perisse, D., Consoli, A., & Laurent, C. (2013). Risperidone or aripiprazole in children and adolescents with autism and/or intellectual disability: A Bayesian meta-analysis of efficacy and secondary effects. *Research in Autism Spectrum Disorders*, 7(1), 167–175.
- Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Academic press.
- Conner, C. M., Golt, J., Righi, G., Shaffer, R., Siegel, M., & Mazefsky, C. A. (2020). A comparative study of suicidality and its association with emotion regulation impairment in large ASD and US census-matched samples. *Journal of Autism and Developmental Disorders*, 50, 3545–3560.
- Conner, C. M., Golt, J., Shaffer, R., Righi, G., Siegel, M., & Mazefsky, C. A. (2021). Emotion dysregulation is substantially elevated in autism compared to the general population: Impact on psychiatric services. *Autism Research*, 14(1), 169–181.
- Conner, C. M., Kim, P. S., White, S. W., & Mazefsky, C. A. (2022). The role of emotion dysregulation and intolerance of uncertainty in autism: Transdiagnostic factors influencing co-occurring conditions. *Research in Developmental Disabilities*, 130, 104332.
- Connor-Smith, J. K., Compas, B. E., Wadsworth, M. E., Thomsen, A. H., & Saltzman, H. (2000). Responses to stress in adolescence: Measurement of coping and involuntary stress responses. *Journal of Consulting and Clinical Psychology*, 68(6), 976.
- Cook, B., Buysse, V., Klingner, J., Landrum, T., McWilliam, R., Tankersley, M., & Test, D. (2014). Council for Exceptional Children: Standards for evidence-based practices in special education. *Teaching Exceptional Children*, 46(6), 206.
- Costa, A. P., Steffgen, G., & Vögele, C. (2019a). The role of alexithymia in parent-child interaction and in the emotional ability of children with autism spectrum disorder. *Autism Research*, 12(3), 458–468.

- Costa, A. P., Steffgen, G., & Vögele, C. (2019b). The role of alexithymia in parent-child interaction and in the emotional ability of children with autism spectrum disorder. *Autism Research*, 12(3), 458–468.
- Day, T. N., Northrup, J. B., & Mazefsky, C. A. (2023). A PROMIS® ing new measure for quantifying emotion dysregulation in toddlers and preschoolers: Development of the emotion dysregulation inventory-young child. *Journal of Autism and Developmental Disorders*, 53(6), 2261–2273.
- DeFilippis, M. (2018). Depression in children and adolescents with autism spectrum disorder. *Children*, 5(9), 112.
- DeLucia, E. A., McKenna, M. P., Andrzejewski, T. M., Valentino, K., & McDonnell, C. G. (2021). A pilot study of self-regulation and behavior problems in preschoolers with ASD: Parent broader autism phenotype traits relate to child emotion regulation and inhibitory control. *Journal of Autism and Developmental Disorders*, 1–15.
- Driver, B., & Chester, V. (2021). The presentation, recognition and diagnosis of autism in women and girls. *Advances in Autism*, 7(3), 194–207.
- Dworzynski, K., Ronald, A., Bolton, P., & Happé, F. (2012). How different are girls and boys above and below the diagnostic threshold for autism spectrum disorders? *Journal of the American Academy of Child & Adolescent Psychiatry*, 51(8), 788–797.
- Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *Bmj*, 315(7109), 629–634.
- Einfeld, S. L., Beaumont, R., Clark, T., Clarke, K. S., Costley, D., Gray, K. M., ... Sofronoff, K. (2018). School-based social skills training for young people with autism spectrum disorders. *Journal of Intellectual & Developmental Disability*, 43(1), 29–39.
- Eisenberg, N., Fabes, R. A., Nyman, M., Bernzweig, J., & Pinuelas, A. (1994). The relations of emotionality and regulation to children's anger-related reactions. *Child Development*, 65(1), 109–128.
- Fabes, R. A., Eisenberg, N., Karbon, M., Troyer, D., & Switzer, G. (1994). The relations of children's emotion regulation to their vicarious emotional responses and comforting behaviors. *Child Development*, 65(6), 1678–1693.
- Fenning, R. M., Baker, J. K., & Moffitt, J. (2018). Intrinsic and extrinsic predictors of emotion regulation in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 48, 3858–3870.
- Fieiras, C., Chen, M. H., Liquitay, C. M. E., Meza, N., Rojas, V., Franco, J. V. A., & Madrid, E. (2023). Risperidone and aripiprazole for autism spectrum disorder in children: An overview of systematic reviews. *BMJ Evidence-Based Medicine*, 28(1), 7–14.
- Gadow, K. D., Devincent, C. J., Pomeroy, J., & Azizian, A. (2005). Comparison of DSM-IV symptoms in elementary school-age children with PDD versus clinic and community samples. *Autism*, 9(4), 392–415.
- Garnefski, N., Kraaij, V., & Spinhoven, P. (2001). Negative life events, cognitive emotion regulation and emotional problems. *Personality and Individual Differences*, 30(8), 1311–1327.
- Goerlich, K. S., & Votinov, M. (2023). Hormonal abnormalities in alexithymia. *Frontiers in Psychiatry*, 13, 1070066.
- Goldsmith, H. H., & Rothbart, M. K. (1999). *The laboratory temperament assessment battery (LAB-TAB): Prelocomotor version, technical manual*. Department of Psychology, University of Wisconsin.
- Gormley, E., Ryan, C., & McCusker, C. (2022). Alexithymia is associated with emotion dysregulation in young people with autism spectrum disorder. *Journal of Developmental and Physical Disabilities*, 34(1), 171–186.
- Graziano, P. A., & Garcia, A. (2016). Attention-deficit hyperactivity disorder and children's emotion dysregulation: A meta-analysis. *Clinical Psychology Review*, 46, 106–123.
- Grolnick, W. S., Bridges, L. J., & Connell, J. P. (1996). Emotion regulation in two-year-olds: Strategies and emotional expression in four contexts. *Child Development*, 67(3), 928–941.
- Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, 2(3), 271–299.
- Gross, J. J. (2001). Emotion regulation in adulthood: Timing is everything. *Current Directions in Psychological Science*, 10(6), 214–219.
- Gross, J. J. (2013). Emotion regulation: Taking stock and moving forward. *Emotion*, 13(3), 359.
- Gross, J. J., & Jazaieri, H. (2014). Emotion, emotion regulation, and psychopathology: An affective science perspective. *Clinical Psychological Science*, 2(4), 387–401.
- Guy, L., Souders, M., Bradstreet, L., DeLussey, C., & Herrington, J. D. (2014). Brief report: Emotion regulation and respiratory sinus arrhythmia in autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 44, 2614–2620.
- Hendrix, N. M., Pickard, K. E., Binion, G. E., & Kushner, E. (2022). A systematic review of emotion regulation in parent-mediated interventions for autism spectrum disorder. *Frontiers in Psychiatry*, 13, 846286.
- Higgins, J. P. T., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine*, 21(11), 1539–1558.
- Hirschler-Guttenberg, Y., Golan, O., Ostfeld-Etzion, S., & Feldman, R. (2015). Mothering, fathering, and the regulation of negative and positive emotions in high-functioning preschoolers with autism spectrum disorder. *Journal of Child Psychology and Psychiatry*, 56(5), 530–539.
- Hossain, M. M., Khan, N., Sultana, A., Ma, P., McKyer, E. L. J., Ahmed, H. U., & Purohit, N. (2020). Prevalence of comorbid psychiatric disorders among people with autism spectrum disorder: An umbrella review of systematic reviews and meta-analyses. *Psychiatry Research*, 287, 112922.
- Jacobs, E., & Nader-Grosbois, N. (2020). Affective and cognitive theory of mind in children with intellectual disabilities: How to train them to foster social adjustment and emotion regulation. *Journal of Education and Training Studies*, 8, 80–97.
- Jahromi, L. B., Bryce, C. I., & Swanson, J. (2013). The importance of self-regulation for the school and peer engagement of children with high-functioning autism. *Research in Autism Spectrum Disorders*, 7(2), 235–246.
- Jahromi, L. B., Kasari, C. L., McCracken, J. T., Lee, L. S., Aman, M. G., McDougle, C. J., ... Posey, D. J. (2009). Positive effects of methylphenidate on social communication and self-regulation in children with pervasive developmental disorders and hyperactivity. *Journal of Autism and Developmental Disorders*, 39, 395–404.
- Jahromi, L. B., Kirkman, K. S., Friedman, M. A., & Nunnally, A. D. (2021). Associations between emotional competence and prosocial behaviors with peers among children with autism spectrum disorder. *American Journal on Intellectual and Developmental Disabilities*, 126(2), 79–96.
- Jahromi, L. B., Meek, S. E., & Ober-Reynolds, S. (2012). Emotion regulation in the context of frustration in children with high functioning autism and their typical peers. *Journal of Child Psychology and Psychiatry*, 53(12), 1250–1258.
- Kaat, A. J., Gadow, K. D., & Lecavalier, L. (2013). Psychiatric symptom impairment in children with autism spectrum disorders. *Journal of Abnormal Child Psychology*, 41, 959–969.
- Kaat, A. J., & Lecavalier, L. (2013). Disruptive behavior disorders in children and adolescents with autism spectrum disorders: A review of the prevalence, presentation, and treatment. *Research in Autism Spectrum Disorders*, 7(12), 1579–1594.
- Konstantareas, M. M., & Stewart, K. (2006). Affect regulation and temperament in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 36, 143–154.
- Lai, M.-C., Kasse, C., Besney, R., Bonato, S., Hull, L., Mandy, W., ... Ameis, S. H. (2019). Prevalence of co-occurring mental health diagnoses in the autism population: A systematic review and meta-analysis. *The Lancet Psychiatry*, 6(10), 819–829.
- Lavender, J. M., Tull, M. T., DiLillo, D., Messman-Moore, T., & Gratz, K. L. (2017). Development and validation of a state-based measure of emotion dysregulation: The state difficulties in emotion regulation scale (S-DERS). *Assessment*, 24(2), 197–209.
- Lecavalier, L., McCracken, C. E., Aman, M. G., McDougle, C. J., McCracken, J. T., Tierney, E., ... Handen, B. (2019). An exploration of concomitant psychiatric disorders in children with autism spectrum disorder. *Comprehensive Psychiatry*, 88, 57–64.
- Limaye, D., Limaye, V., Pitani, R. S., Fortwengel, G., Sydymanov, A., Oztzipka, C., & Ziesenis, P. (2018). *Development of a quantitative scoring method for STROBE checklist*.
- Lin, H.-Y., Ni, H.-C., Tseng, W.-Y. I., & Gau, S. S.-F. (2020). Characterizing intrinsic functional connectivity in relation to impaired self-regulation in intellectually able male youth with autism spectrum disorder. *Autism*, 24(5), 1201–1216.
- Lischke, A., Pahnke, R., Mau-Moeller, A., Jacksteit, R., & Weippert, M. (2020). Sex-specific relationships between interoceptive accuracy and emotion regulation. *Frontiers in Behavioral Neuroscience*, 14, 67.
- López-Pérez, B., Ambrona, T., & Gummerum, M. (2018). Emotional preferences and goals and emotion dysregulation in children with Asperger's syndrome and typically developing children. *British Journal of Clinical Psychology*, 57(3), 274–290.
- Lugo-Marín, J., Magan-Maganto, M., Rivero-Santana, A., Cuellar-Pompa, L., Alviani, M., Jenaro-Rio, C., Diez, E., & Canal-Bedia, R. (2019). Prevalence of psychiatric disorders in adults with autism spectrum disorder: A systematic review and meta-analysis. *Research in Autism Spectrum Disorders*, 59, 22–33.
- Mahler, K., Hample, K., Jones, C., Sensenig, J., Thomasco, P., & Hilton, C. (2022). Impact of an interoception-based program on emotion regulation in autistic children. *Occupational Therapy International*, 2022.
- Mazefsky, C. A., Borue, X., Day, T. N., & Minshew, N. J. (2014). Emotion regulation patterns in adolescents with high-functioning autism spectrum disorder: Comparison to typically developing adolescents and association with psychiatric symptoms. *Autism Research*, 7(3), 344–354.
- Mazefsky, C. A., & White, S. W. (2014). Emotion regulation: Concepts & practice in autism spectrum disorder. *Child and Adolescent Psychiatric Clinics*, 23(1), 15–24.
- Mazefsky, C. A., Yu, L., White, S. W., Siegel, M., & Pilkonis, P. A. (2018). The emotion dysregulation inventory: Psychometric properties and item response theory calibration in an autism spectrum disorder sample. *Autism Research*, 11(6), 928–941.
- McRae, K., Rekschan, W., Williams, L. M., Cooper, N., & Gross, J. J. (2014). Effects of antidepressant medication on emotion regulation in depressed patients: An iSPOT-D report. *Journal of affective disorders*, 159, 127–132.
- Morawetz, C., Bode, S., Derntl, B., & Heekeren, H. R. (2017). The effect of strategies, goals and stimulus material on the neural mechanisms of emotion regulation: A meta-analysis of fMRI studies. *Neuroscience & Biobehavioral Reviews*, 72, 111–128.
- Ni, H.-C., Lin, H.-Y., Chen, Y.-C., Tseng, W.-Y. I., & Gau, S. S.-F. (2020). Boys with autism spectrum disorder have distinct cortical folding patterns underpinning impaired self-regulation: A surface-based morphometry study. *Brain Imaging and Behavior*, 14, 2464–2476.
- Ni, H.-C., Lin, H.-Y., Tseng, W.-Y. I., Chiu, Y.-N., Wu, Y.-Y., Tsai, W.-C., & Gau, S. S.-F. (2018). Neural correlates of impaired self-regulation in male youths with autism spectrum disorder: A voxel-based morphometry study. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 82, 233–241.
- Nuske, H. J., Hedley, D., Woollacott, A., Thomson, P., Macari, S., & Dissanayake, C. (2017). Developmental delays in emotion regulation strategies in preschoolers with autism. *Autism Research*, 10(11), 1808–1822.
- de Pablo, G. S., Jordá, C. P., Vaquerizo-Serrano, J., Moreno, C., Cabras, A., Arango, C., ... Fusar-Poli, P. (2023). Systematic review and meta-analysis: Efficacy of pharmacological interventions for irritability and emotional dysregulation in autism spectrum disorder and predictors of response. *Journal of the American Academy of Child & Adolescent Psychiatry*, 62(2), 151–168.
- Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... Brennan, S. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. *Bmj*, 372.
- Paulus, F. W., Ohmann, S., Möhler, E., Plener, P., & Popow, C. (2021). Emotional dysregulation in children and adolescents with psychiatric disorders. A narrative review. *Frontiers in Psychiatry*, 12, 628252.

- Pouw, L. B. C., Rieffe, C., Stockmann, L., & Gadow, K. D. (2013). The link between emotion regulation, social functioning, and depression in boys with ASD. *Research in Autism Spectrum Disorders*, 7(4), 549–556.
- Ratto, A. B., Kenworthy, L., Yerys, B. E., Bascom, J., Wieckowski, A. T., White, S. W., ... Ollendick, T. H. (2018). What about the girls? Sex-based differences in autistic traits and adaptive skills. *Journal of Autism and Developmental Disorders*, 48, 1698–1711.
- Reyes, N. M., Factor, R., & Scarpa, A. (2020). Emotion regulation, emotionality, and expression of emotions: A link between social skills, behavior, and emotion problems in children with ASD and their peers. *Research in Developmental Disabilities*, 106, 103770.
- Reyes, N. M., Pickard, K., & Reaven, J. (2019). Emotion regulation: A treatment target for autism spectrum disorder. *Bulletin of the Menninger Clinic*, 83(3), 205–234.
- Rieffe, C., De Bruine, M., De Rooij, M., & Stockmann, L. (2014). Approach and avoidant emotion regulation prevent depressive symptoms in children with an autism spectrum disorder. *International Journal of Developmental Neuroscience*, 39, 37–43.
- Rieffe, C., Oosterveld, P., Terwogt, M. M., Mootz, S., Van Leeuwen, E., & Stockmann, L. (2011). Emotion regulation and internalizing symptoms in children with autism spectrum disorders. *Autism*, 15(6), 655–670.
- van Rijn, S., Kuiper, K., Bouw, N., Urbanus, E., & Swaab, H. (2023). Neurocognitive and behavioral development in young children (1–7 years) with sex chromosome trisomy. *Endocrine Connections*, 12(5).
- Rispoli, K. M., Malcolm, A. L., Nathanson, E. W., & Mathes, N. E. (2019). Feasibility of an emotion regulation intervention for young children with autism spectrum disorder: A brief report. *Research in Autism Spectrum Disorders*, 67, 101420.
- Rosenberg, R. E., Kaufmann, W. E., Law, J. K., & Law, P. A. (2011). Parent report of community psychiatric comorbid diagnoses in autism spectrum disorders. *Autism Research and Treatment*, 2011.
- Sáez-Suanes, G. P., García-Villamizar, D., & Del Pozo Armentia, A. (2023). The role of intellectual disability and emotional regulation in the autism–depression relationship. *Autism*, 27(7), 1960–1967. <https://doi.org/10.1177/13623613231161881>
- Salazar, F., Baird, G., Chandler, S., Tseng, E., O'sullivan, T., Howlin, P., ... Simonoff, E. (2015). Co-occurring psychiatric disorders in preschool and elementary school-aged children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 45, 2283–2294.
- Samson, A. C., Hardan, A. Y., Podell, R. W., Phillips, J. M., & Gross, J. J. (2015). Emotion regulation in children and adolescents with autism spectrum disorder. *Autism Research*, 8(1), 9–18.
- Samson, A. C., Phillips, J. M., Parker, K. J., Shah, S., Gross, J. J., & Hardan, A. Y. (2014). Emotion dysregulation and the core features of autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 44, 1766–1772.
- Samson, J. L., Rochat, L., Chanal, J., Badoud, D., Perroud, N., & Debbané, M. (2022). The effects of cognitive-affective switching with unpredictable cues in adults and adolescents and their relation to “cool” executive functioning and emotion regulation. *Frontiers in Psychology*, 13, 757213.
- Sanchis-Sanchis, A., Grau, M. D., Moliner, A.-R., & Morales-Murillo, C. P. (2020). Effects of age and gender in emotion regulation of children and adolescents. *Frontiers in Psychology*, 11, 946.
- Scarpa, A., & Reyes, N. M. (2011). Improving emotion regulation with CBT in young children with high functioning autism spectrum disorders: A pilot study. *Behavioural and Cognitive Psychotherapy*, 39(4), 495–500.
- Shaffer, R. C., Schmitt, L. M., Reisinger, D. L., Coffman, M., Horn, P., Goodwin, M. S., ... Erickson, C. A. (2023). Regulating together: Emotion dysregulation group treatment for ASD youth and their caregivers. *Journal of Autism and Developmental Disorders*, 53(5), 1942–1962.
- Shaffer, R. C., Wink, L. K., Ruberg, J., Pittenger, A., Adams, R., Sorter, M., ... Erickson, C. A. (2019). Emotion regulation intensive outpatient programming: Development, feasibility, and acceptability. *Journal of Autism and Developmental Disorders*, 49, 495–508.
- Shea, N., Payne, E., & Russo, N. (2018). Brief report: Social functioning predicts externalizing problem behaviors in autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 48, 2237–2242.
- Sheinkopf, S. J., Levine, T. P., McCormick, C. E. B., Puggioni, G., Conradt, E., Lagasse, L. L., & Lester, B. M. (2019). Developmental trajectories of autonomic functioning in autism from birth to early childhood. *Biological Psychology*, 142, 13–18.
- Sheppes, G., Suri, G., & Gross, J. J. (2015). Emotion regulation and psychopathology. *Annual Review of Clinical Psychology*, 11, 379–405.
- Shields, A., & Cicchetti, D. (1998). Reactive aggression among maltreated children: The contributions of attention and emotion dysregulation. *Journal of Clinical Child Psychology*, 27(4), 381–395.
- Springstein, T., & English, T. (2023). Studying emotion regulation success in daily life: Distinctions from maladaptive regulation and dysregulation. *Personality and Social Psychology Review*, 0(0), 10888683231199140.
- Sukhodolsky, D. G., Scahill, L., Gadow, K. D., Arnold, L. E., Aman, M. G., McDougle, C. J., ... Lecavalier, L. (2008). Parent-rated anxiety symptoms in children with pervasive developmental disorders: Frequency and association with core autism symptoms and cognitive functioning. *Journal of Abnormal Child Psychology*, 36, 117–128.
- Te Brinke, L. W., Schuiringa, H. D., & Matthys, W. (2021). Emotion regulation and angry mood among adolescents with externalizing problems and intellectual disabilities. *Research in Developmental Disabilities*, 109, 103833.
- Te Brinke, L. W., Schuiringa, H. D., Menting, A. T. A., Deković, M., Westera, J. J., & De Castro, B. O. (2022). Treatment approach and sequence effects in cognitive behavioral therapy targeting emotion regulation among adolescents with externalizing problems and intellectual disabilities. *Cognitive Therapy and Research*, 1–17.
- Thirion-Marissiaux, A.-F., & Nader-Grosbois, N. (2008). Theory of mind “emotion”, developmental characteristics and social understanding in children and adolescents with intellectual disabilities. *Research in Developmental Disabilities*, 29(5), 414–430.
- Thompson, R. A. (1994). Emotion regulation: A theme in search of definition. *Monographs of the Society for Research in Child Development*, 25–52.
- Tick, B., Bolton, P., Happé, F., Rutter, M., & Rijdsdijk, F. (2016). Heritability of autism spectrum disorders: A meta-analysis of twin studies. *Journal of Child Psychology and Psychiatry*, 57(5), 585–595.
- Tse, A. C. Y. (2020). Brief report: Impact of a physical exercise intervention on emotion regulation and behavioral functioning in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 50(11), 4191–4198.
- Tull, M. T., & Aldao, A. (2015). Editorial overview: New directions in the science of emotion regulation. *Current Opinion in Psychology*, 3, iv–x.
- Weiss, J. A., Thomson, K., & Chan, L. (2014). A systematic literature review of emotion regulation measurement in individuals with autism spectrum disorder. *Autism Research*, 7(6), 629–648.
- White, S. W., Mazefsky, C. A., Dichter, G. S., Chiu, P. H., Richey, J. A., & Ollendick, T. H. (2014). Social-cognitive, physiological, and neural mechanisms underlying emotion regulation impairments: Understanding anxiety in autism spectrum disorder. *International Journal of Developmental Neuroscience*, 39, 22–36.
- White, S. W., & Roberson-Nay, R. (2009). Anxiety, social deficits, and loneliness in youth with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 39, 1006–1013.
- Wood-Downie, H., Wong, B., Kovshoff, H., Cortese, S., & Hadwin, J. A. (2021). Research Review: A systematic review and meta-analysis of sex/gender differences in social interaction and communication in autistic and nonautistic children and adolescents. *Journal of Child Psychology and Psychiatry*, 62(8), 922–936.
- Yager, J., & Iarocci, G. (2013). The development of the multidimensional social competence scale: A standardized measure of social competence in autism spectrum disorders. *Autism Research*, 6(6), 631–641.
- Zantinge, G., van Rijn, S., Stockmann, L., & Swaab, H. (2017). Physiological arousal and emotion regulation strategies in young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 47, 2648–2657.
- Zeidan, J., Fombonne, E., Scorsah, J., Ibrahim, A., Durkin, M. S., Saxena, S., ... Elsabbagh, M. (2022). Global prevalence of autism: A systematic review update. *Autism Research*, 15(5), 778–790.