



Emotion regulation difficulties in children and adolescents with obsessive-compulsive disorder



PhD Thesis

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Studies in the thesis

I. Frequency and types of emotional dysregulation in referrals to child and adolescent mental health services

Short title¹: **The referral study**

Emilie Ellehauge, **Christine Lykke Thoustrup**, Mette Nørgaard Nielsen, Anne Katrine Pagsberg, Julie Hagstrøm. *Acta Psychiatrica Scandinavica*. 2023; 148: 165-178.

II. Normative reference interval for youths on the Difficulties in Emotion Regulation Scale (DERS)

Short title: **The DERS study**

Christine Lykke Thoustrup and Markus Harboe Olsen. Thoustrup. Rapid communication in *Scandinavian Journal of Child and Adolescent Psychiatry and Psychology*, 12(1): 139-144.

III. Emotion regulation difficulties in children and adolescents with obsessive-compulsive disorder: A multi-informant and multi-method study

Short title: **The OCD baseline study**

Christine Lykke Thoustrup, Robert James Blair, Sofie Heidenheim Christensen, Valdemar Uhre, Linea Pretzmann, Nicoline Løcke Jepsen Korsbjerg, Camilla Uhre, Anna-Rosa Cecilie Mora-Jensen, Melanie Ritter, Nicole Nadine Lønfeldt, Emilie Damløv Thorsen, Daniel S. Quintana, Ahmad Sajadieh, Jakob Hartvig Thomsen, Kerstin Jessica Plessen, Signe Vangkilde, Anne Katrine Pagsberg, Julie Hagstrøm. *Manuscript under post-revision review*.

IV. Implications of emotion regulation difficulties for psychotherapy in pediatric OCD

Short title: **The OCD treatment study**

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¹ To improve readability and conciseness, short titles will be used throughout the thesis to refer to the studies of interest.

Publications (not part of the thesis)

- 1) **Thoustrup, C. L.**, Uhre, C., Uhre, V., Ritter, M., Vangkilde, S., Engstrøm, J., Lindschou, J., Gluud, C., Pagsberg, A. K., & Olsen, M. H. (2025). Emotion dysregulation in youths with obsessive-compulsive disorder and its implication for treatment - An exploratory study from the TECTO trial: A protocol and statistical analysis plan. *Contemporary Clinical Trials Communications*, 43, 101408. <https://doi.org/10.1016/j.conctc.2024.101408>
- 2) Mora-Jensen, A.-R., Clemmensen, L., Grønberg, M., Lebowitz, E., Quintana, D., Jørgensen, N. R., Larsen, C., Bak, L., Christensen, G., Pretzmann, L., Uhre, V., Christensen, S., Uhre, C., Korsbjerg, N., **Thoustrup, C.L.**, Hagstrøm, J., Ritter, M., Plessen, K., Pagsberg, A., & Lønfeldt, N. (2024). The association between salivary oxytocin, age, and puberty in children with and without OCD. *Scientific Reports*, 14. <https://doi.org/10.1038/s41598-024-80194-8>
- 3) Pretzmann, L., Christensen, S. H., Bryde Christensen, A., Funch Uhre, C., Uhre, V., **Thoustrup, C. L.**, Clemmesen, I. T., Gudmandsen, T. A., Korsbjerg, N. L. J., Mora-Jensen, A.-R. C., Ritter, M., Olsen, M. H., Clemmensen, L. K. H., Lindschou, J., Gluud, C., Thomsen, P. H., Vangkilde, S., Hagstrøm, J., Rozental, A., ... Pagsberg, A. K. (2023). Adverse events in cognitive behavioral therapy and relaxation training for children and adolescents with obsessive-compulsive disorder: A mixed methods study and analysis plan for the TECTO trial. *Contemporary Clinical Trials Communications*, 34, 101173. <https://doi.org/10.1016/j.conctc.2023.101173>
- 4) Pagsberg, A. K., Uhre, C., Uhre, V., Pretzmann, L., Christensen, S. H., **Thoustrup, C.L.**, Clemmesen, I., Gudmandsen, A. A., Korsbjerg, N. L. J., Mora-Jensen, A.-R. C., Ritter, M., Thorsen, E. D., Halberg, K. S. V., Bugge, B., Staal, N., Ingstrup, H. K., Moltke, B. B., Kloster, A. M., Zoega, P. J., ... Plessen, K. J. (2022). Family-based cognitive behavioural therapy versus family-based relaxation therapy for obsessive-compulsive disorder in children and adolescents: Protocol for a randomised clinical trial (the TECTO trial). *BMC Psychiatry* 22(1), 204. <https://doi.org/10.1186/s12888-021-03669-2>
- 5) Olsen, M. H., Hagstrøm, J., Lønfeldt, N. N., Uhre, C., Uhre, V., Pretzmann, L., Christensen, S. H., **Thoustrup, C.L.**, Korsbjerg, N. L. J., Mora-Jensen, A.-R. C., Ritter, M., Engstrøm, J., Lindschou, J., Siebner, H. R., Verhulst, F., Jeppesen, P., Jepsen, J. R. M., Vangkilde, S., Thomsen, P. H., ... Jakobsen, J. C. (2022). Family-based cognitive behavioural therapy versus family-based relaxation therapy for obsessive-compulsive disorder in children and adolescents (the TECTO trial): A statistical analysis plan for the randomised clinical trial. *Trials*, 23(1), 854. <https://doi.org/10.1186/s13063-022-06799-4>

List of abbreviations

The following abbreviations are used throughout this thesis.

ADIS-IV-P	Anxiety Disorders Interview Schedule for DSM-IV, Parent Version
ADIS-C/P	Anxiety Disorders Interview Schedule for DSM-IV-Child and Parent Version
BRIEF	Behavior Rating Inventory of Executive Function
BRIEF-EC	Behavior Rating Inventory of Executive Function Emotional Control
CAMHC	Child and Adolescent Mental Health Center, Mental Health Services, Capital Region of Denmark
CAMHS	Child and Adolescent Mental Health Services
CBCL	Child Behavior Checklist
CBCL-DP	Child Behavior Checklist-Dysregulation Profile
CBT	Cognitive-behavioral therapy
CERQ	Cognitive Emotion Regulation Questionnaire
CGI-I	Clinical Global Impression-Improvement
CGI-S	Clinical Global Impression-Severity
COIS-P/C	Child Obsessive Compulsive Impact Scale– Parent/Child
CY-BOCS	Children’s Yale-Brown Obsessive Compulsive Scale
DERS	Difficulties in Emotion Regulation Scale
DIAMOND-KID	Diagnostic Interview for Anxiety, Mood, and Obsessive–Compulsive and Related Neuropsychiatric Disorders semi-structured interview—Child and Adolescent Version
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
ECG	Electrocardiogram
EmReg	Overall ER score from the TEC-M
ER	Emotion regulation
ERC	Emotion Regulation Checklist
ERD	Emotion regulation difficulties
ERQ-CA	Emotion Regulation Questionnaire for Children and Adolescents

ERP	Exposure and response prevention
FA	Family accommodation
FAS	Family Accommodation Scale
FAS-SR	Family Accommodation Scale Self-report
FCBT	Family-based cognitive-behavioral therapy
FPRT	Family-based psychoeducation and relaxation training
GAD	Generalized anxiety disorder
HF-HRV	High-frequency heart rate variability
HRV	Heart rate variability
ICD-10	International Statistical Classification of Diseases and Related Health Problems, 10 th Revision
ICD-11	International Classification of Diseases, 11 th Revision
IQ	Intelligence quotient
K-SADS-PL	Kiddie Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version
MASC	Multidimensional Anxiety Scale for Children
MASC-2	The Multidimensional Anxiety Scale for Children – Second Edition
OCD	Obsessive-compulsive disorder
OCI-CV	Obsessive Compulsive Inventory – Child version
OCS	Obsessive compulsive symptomatology
RMSSD	Root mean square of successive differences of R-R intervals
SAD	Social anxiety disorder
SNAP-IV-P	Attention-Deficit and Hyperactivity Symptoms The Swanson, Nolan, and Pelham-IV-Parent Report
STAI-C	The State-Trait Anxiety Inventory for Children
TEC-M	Tangram Emotion Coding Manual
TECTO	Treatment Effects of Family Based Cognitive Therapy in Children and Adolescents with Obsessive Compulsive Disorder
VAS	Visual analogue scale
WAIS-IV	Wechsler Adult Intelligence Scale, Fourth Edition
WISC-R	Wechsler Intelligence Scale for Children, Revised Short Form
WISC-V	Wechsler Intelligence Scale for Children, Fifth Edition

Thesis summary

Emotion regulation (ER) is essential for adaptive functioning in daily life and undergoes significant development throughout childhood and adolescence. Difficulties in ER are implicated in a range of psychopathologies, including pediatric obsessive-compulsive disorder (OCD). However, evidence on ER in pediatric OCD is limited by a narrow range of methods and methodological inconsistencies, hindering a comprehensive understanding of ER's role in the disorder. The primary aim of this thesis was to enhance knowledge of ER difficulties in children and adolescents with OCD before and after treatment (the OCD baseline and treatment studies). Secondary aims included 1) contextualizing ER difficulties within the broader landscape of youth mental health (the referral study) and 2) improving interpretation of the ER questionnaire used in the OCD studies (the DERS study).

In the referral study, we conducted a retrospective chart review to explore the prevalence of ER difficulties among children and adolescents referred to mental health services in the Capital Region of Denmark. The findings indicated that a significant proportion of referred children and adolescents exhibited notable ER difficulties, with ER difficulties being the primary concern in twice as many rejected referrals compared to accepted referrals. Furthermore, ER difficulties varied by sex and age.

In the DERS study, we estimated a 90% reference interval for normative ER using the Difficulties in Emotion Regulation Scale (DERS) to establish a cutoff score distinguishing normative from abnormal ER. Our findings suggested that a total score above 121.8 on the DERS is indicative of abnormal ER abilities.

In the OCD baseline and treatment studies, we examined ER difficulties in children and adolescents with OCD before and after treatment. The baseline study suggested that children and adolescents with OCD and their parents reported more severe child ER difficulties compared to non-clinical peers and exhibited greater ER difficulties during a frustration task. Nevertheless, the study did not detect OCD-related aberrant heart rate variability (HRV). The OCD treatment study suggested that ER difficulties decrease for adolescents receiving family-based cognitive behavioral therapy but not for those receiving family-based psychoeducation and relaxation training. Notably, ER difficulties appeared not to moderate or mediate treatment outcomes.

Taken together, these findings reinforce and extend existing research linking ER difficulties to youth mental health, suggesting that ER difficulties may decrease following treatment, alongside psychopathological symptoms. Future research should employ more fine-grained designs to explore ER difficulties in children and adolescents, considering social, familial, developmental, and symptom-specific factors. Such approaches could help inform targeted prevention strategies and improve personalized treatment effectiveness.

Danish resumé (Dansk resumé)

Evnen til at regulere egne følelser er afgørende for et godt funktionsniveau. Denne evne gennemgår en væsentlig udvikling i løbet af barne- og ungdomsårene. Vanskeligheder med følelsesregulering er tæt forbundet med en lang række mentale lidelser, herunder obsessiv-kompulsiv lidelse (OCD) i barndommen. Den eksisterende viden om sammenhængen mellem OCD og følelsesreguleringsvanskeligheder er næsten udelukkende baseret på spørgeskemaundersøgelser. Desuden omfatter behandlingsstudierne på området mange forskellige terapeutiske tilgange. Dette gør det vanskeligt at få en tydelig forståelse af, hvilken rolle følelsesregulering spiller for børn med OCD.

Det primære formål med denne afhandling var at øge forståelsen af følelsesreguleringsvanskeligheder hos børn og unge med OCD før og efter psykoterapeutisk behandling (Studie I og II). De sekundære formål var 1) at vurdere børns følelsesreguleringsvanskeligheder set i et bredere transdiagnostisk perspektiv (Studie I) samt 2) at kvalificere anvendelsen og fortolkningen af spørgeskemaet om følelsesregulering (the Difficulties in Emotion Regulation Scale, DERS), der anvendes i OCD-studierne (Studie II).

I Studie I kortlagde vi via en retrospektiv journalgennemgang forekomsten af følelsesreguleringsvanskeligheder blandt børn og unge henvist til børne- og ungdomspsykiatrien i Region Hovedstaden. Resultaterne viste, at en betydelig andel af de henviste børn og unge havde markante vanskeligheder med følelsesregulering. Disse vanskeligheder var den primære årsag til henvisning i dobbelt så mange af de afviste som accepterede henvisninger. Derudover fandt vi, at typen og hyppigheden af følelsesreguleringsvanskeligheder varierede afhængigt af køn og alder.

I Studie II beregnede vi et 90% referenceinterval for normal følelsesregulering ved hjælp af spørgeskemaet DERS. Formålet var at etablere en grænseværdi, der adskiller normal fra abnormal følelsesregulering. Vores resultater indikerede, at en samlet score på DERS over 121,8 er tegn på abnormal følelsesregulering.

I Studie III and IV undersøgte vi følelsesreguleringsvanskeligheder hos børn og unge med OCD før og efter psykoterapeutisk behandling. Studie III viste, at både børn og unge med OCD og deres forældre rapporterede, at børnene og de unge havde flere følelsesreguleringsvanskeligheder sammenlignet med raske kontroller. Derudover fandt vi ved systematisk observation, at børn og unge med OCD havde sværere ved at regulere deres følelser under en frustrationsopgave sammenlignet med børn uden psykisk sygdom. Vi fandt imidlertid ikke forskelle i hjerterytmevariabilitet mellem børn og unge med og uden OCD. Studie IV viste, at følelsesreguleringsvanskelighederne blev reduceret hos de unge, der modtog familiebaseret kognitiv adfærdsterapi, men ikke hos dem, der modtog familiebaseret afspændingsterapi. Endelig fandt vi, at

følelsesreguleringsvanskelighederne tilsyneladende ikke modererede eller medierede behandlingsresultaterne.

Samlet set understøtter og udvider disse resultater den eksisterende forskning, der kobler følelsesreguleringsvanskeligheder med børn og unges mentale sundhed. Vores fund indikerer, at disse vanskeligheder kan afhjælpes med relevant behandling – i hvert fald for OCD - samtidig med at psykopatologiske symptomer mindskes. Fremtidig forskning bør anvende forskningsdesigns, som i højere grad undersøger følelsesreguleringsvanskelighederne med inddragelse af faktorer i barnets og den unges kontekst. Dette indebærer både sociale og familiære faktorer samt udviklingstrin og eventuelle symptomdimensioner. En sådan tilgang kan bidrage til at udvikle mere målrettede forebyggelsesstrategier og optimere mulighederne for individuelt tilpasset behandling.

Progression of the project

My journey into the world of science began with a deep fascination for ER, a crucial yet scientifically complex topic. To my surprise and good fortune, ER had not yet been addressed in the large trial on pediatric OCD, which was about to begin at the Child and Adolescent Mental Health Center, Mental Health Services, Capital Region of Denmark (CAMHC). Therefore, I was happy to accept the offered position as a research assistant, along with the opportunity to develop a protocol for assessing ER in children and adolescents with OCD.

Over the following years, I dedicated myself to clinical work, gathering data on both children with OCD and their healthy peers. This experience was inspiring, intellectually stimulating, and profoundly meaningful. While I had not originally planned to pursue a PhD, I seized the opportunity when a grant was offered. And as a result, the central theme of this thesis explores the relationship between ER and OCD.

My passion for ER led me to another fortunate opportunity when my co-supervisor, Julie Hagstrøm invited me to collaborate on a study examining the frequency of ER difficulties in children and adolescents referred for mental health services. In addition, while working clinically with one of the ER measures in the OCD trial, I noticed a lack of standardized norms, which could complicate the interpretation of scores, both clinically and scientifically. This led me to wonder whether establishing a cut-off between normative and abnormal ER – using a 90% reference interval based on existing literature – could improve the interpretation.

This thesis represents the culmination of my journey—from a deep interest in ER to securing a position with an exceptional OCD research team, exploring ER within this context, and meeting inspiring collaborators who invited me to contribute to meaningful projects. While the overarching theme of this work is ER, my clinical focus has been on pediatric OCD. Therefore, the primary objective of this thesis is to explore the connection between ER and OCD (Studies III and IV), with the referral and DERS studies (Studies I and II) providing essential context to understand the significance and complexity of ER.

Outline of the thesis

Chapter 1: Introduction provides an overview of ER, including its conceptualization, measurement, and its role in child development and psychopathology. It also introduces pediatric OCD, focusing on clinical features, treatment approaches, and the existing literature on ER difficulties in the context of OCD. The

chapter emphasizes ER as a crucial developmental factor and highlights its transdiagnostic relevance to mental health in childhood and adolescence. Furthermore, it identifies important gaps in the current literature, emphasizing the need for further research, thereby setting the stage for the aims of this PhD thesis.

Chapter 2: Shared methods for the OCD studies outlines the methodological framework for the OCD baseline and treatment studies, beginning with an introduction to the TECTO trial. It then provides a detailed description of the methods employed in the ER sub-study, which includes both the OCD baseline and treatment studies.

Chapter 3: Summary of studies presents an overview of the four studies included in the thesis, structured by background, aim, methods, and results for each study. This section addresses the gaps identified in the introduction and provides empirical evidence that contributes to the subsequent discussion.

Chapter 4: General discussion synthesizes the main findings from the four studies, situating them within the broader context of existing research. It critically examines the implications of these findings for understanding ER as a significant factor in mental health. Finally, it explores the relevance of these findings for clinical practice and provides guidance for future research directions.

Chapter 5: Strengths and limitations highlights the strengths of the four studies, including their design, methodologies, and contributions to the field. It also critically examines the limitations, such as potential biases, methodological constraints, and areas for further improvement.

Chapter 6: Conclusion summarizes the main findings from the studies, discussing their overall implications for the field. It highlights the significance of ER in mental health and offers recommendations for future research and clinical practice.

Chapter 1: Introduction

Childhood and adolescence are critical and formative periods with rapid physical, emotional, and social transformations (Sawyer et al., 2018). While presenting significant opportunities for growth, these stages in life also encompass heightened vulnerability to mental health problems. A recent epidemiological study of a Danish cohort demonstrated that 15% of all youths were diagnosed with a mental disorder before the age of 18 years, consistent with findings from international research (Dalsgaard et al., 2020). This youth mental health crisis has prompted calls from both scientific and clinical societies for research investigating factors contributing to the development and persistence of youth mental disorders (General (OSG), 2021; *The Lancet Psychiatry Commission*, 2024). Such research is crucial for enhancing preventive measures and treatment strategies. While current diagnostic classification systems rely on categorical approaches to psychopathology, a growing body of research argues that dimensional factors underlying these disorders are equally important for understanding the issues at hand and determining the most effective treatments (Dalgleish et al., 2017). One factor, suggested to span multiple domains of functioning and diagnoses, is the ability to regulate emotions (Fernandez et al., 2016). In a recent study, we demonstrated that more than 60% of children and adolescents referred to mental health services in the Capital Region of Denmark exhibited ER difficulties severe enough to be explicitly noted as a main concern in their referrals (Ellehauge et al., 2023). In clinical practice, ER plays a crucial role, as it influences the presentation, progression, and treatment outcomes of mental health conditions (Kring & Sloan, 2009). Despite its significance, notable gaps remain in understanding how ER difficulties manifest within specific populations. This thesis specifically focuses on pediatric OCD. Clinical observations of children and adolescents with OCD reveal that frequent temper outbursts, emotional lability, and feelings of shame are major concerns for the affected families. These challenges suggest underlying ER difficulties. However, as will be demonstrated in a systematic literature search (**Figure 3**), the existing research on ER difficulties in pediatric OCD is scarce and limited by methodological shortcomings, highlighting the need for more robust and comprehensive investigations.

The four studies included in this thesis each address important questions regarding the role of ER in mental health for children and adolescents. The referral study explores how frequently ER difficulties are a main reason for seeking professional help, providing important context by highlighting the prevalence of these challenges. The DERS study aims to establish a benchmark for normative ER by using the DERS, the same questionnaire employed in the OCD studies. The study estimates the 90% reference interval for normative ER based on data from over 7,000 adolescents drawn from community-based and non-clinical samples. The OCD baseline and OCD treatment studies from the Treatment Effects of Family Based Cognitive Therapy in Children and Adolescents with Obsessive Compulsive Disorder (TECTO) trial specifically examine ER

difficulties in pediatric OCD before and after treatment. Together, these studies employ a range of methods and informants to assess ER difficulties across the spectrum of child and adolescent mental health. While the referral and DERS studies serve to contextualize and qualify the problem, the primary focus of this thesis is on the OCD studies.

In this thesis, the term ‘ER difficulties’ refers to challenges in managing the intensity, duration, or expression of emotions, encompassing both emotional control and emotion dysregulation. Additionally, the terms ‘children’ and ‘adolescents’ refer to individuals under the age of 18. These terms will be used interchangeably throughout the thesis, with specific age ranges indicated when needed for clarity.

The introduction is organized as follows: 1) the conceptual framework for ER underpinning this thesis; 2) a clinical characterization of pediatric OCD; and 3) a systematic literature search and overview of relevant findings on ER difficulties in pediatric OCD. This structure is intended to provide a clear and logical foundation for the aims of the thesis.

Defining and conceptualizing emotion regulation

ER is a multi-faceted construct without a single consensus on its definition. Broadly, it can be described as an individual’s ability to manage emotional experiences and responses through biological, cognitive, social, and behavioral processes (Thompson, 1994). Since the mid-1990s, research on ER has grown exponentially. However, much of this work has relied on single-model approaches to define the construct. Responding to recent calls for multi-operationalization in psychological research (Carpentras, 2024), I argue that advancing ER research requires integrating multiple theoretical models and methods to capture its complexity. In this thesis, I draw on two key frameworks of ER to establish the theoretical foundation of our research. The following section presents these models and elaborates on how they can be combined to inform a multi-operationalization approach to ER.

The process model of emotion regulation

The process model of ER, developed by James Gross (1998), describes how emotions are regulated at different time points in the generation of an emotional response. The model posits that ER involves five main families of processes that operate sequentially. The first four groups of processes, *situation selection*, *situation modification*, *attention deployment*, and *cognitive change*, occur early in the emotion generative process and focus on input to the emotion system. The fifth process, *response modulation*, emerges later and

centers on the output of the emotion system (Gross, 2014). Each effort to regulate results in an emotional change, which in turn alters the situation and generates a new context for regulation, as illustrated by the recursive arrow in **Figure 1**.

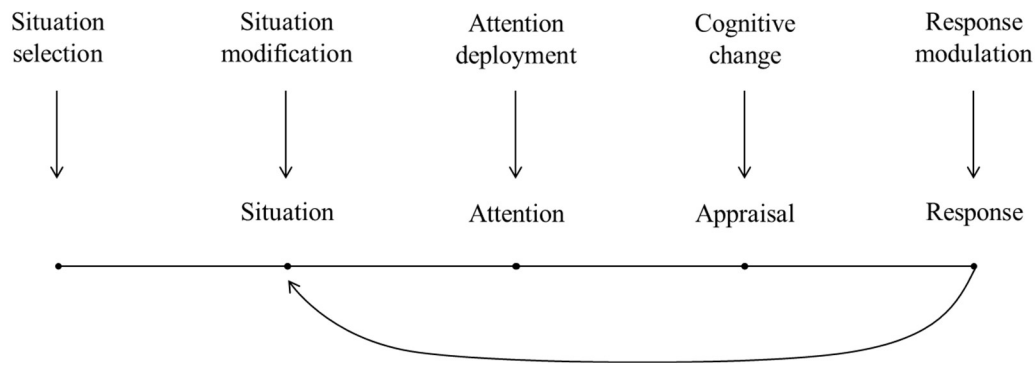


Figure 1. The process model of emotion regulation

Source: Gross, 2014, p. 7. This figure illustrates the Process Model of Emotion Regulation. It outlines the five processes through which individuals may regulate their emotional experiences. The five processes are: **situation selection** (choosing situations to influence emotional outcomes); **situation modification** (altering the situation to modify its emotional impact); **attention deployment** (redirecting focus to influence emotional responses); **cognitive change** (reinterpreting the situation to alter emotional significance); and **response modulation** (directly regulating emotional responses and expressions). The recursive arrow indicates that these processes are dynamic and can influence each other, suggesting that emotion regulation is a flexible, ongoing process.

The process model of ER has been widely used as a theoretical framework for studying ER abilities and difficulties in children and adolescents with and without psychopathology (Young et al., 2019). In a meta-analysis of 35 studies involving adolescents, Schäfer et al. (2017) demonstrated a significant relationship between habitual use of various ER strategies and symptoms of anxiety and depression. Specifically, adaptive ER strategies, such as cognitive reappraisal, problem-solving, and acceptance, were negatively associated with symptoms, whereas maladaptive strategies, such as suppression, rumination, and avoidance, were positively associated. Notably, associations between ER strategies and symptoms of anxiety and depression appear strongest in studies using self-reported outcomes, while studies reporting on behavioral, psychophysiological, and neural outcomes show weaker or non-significant associations (Young et al., 2019). Thus, according to the process model, ER difficulties occur when the individual struggles to manage their emotions effectively, often resorting to maladaptive strategies, which results in emotional responses that are too intense, prolonged, or inappropriate for the given context, or which complicates what the individual is trying to accomplish.

The multidimensional model of emotion regulation

The multidimensional model of ER, defined by Kim Gratz and Lizabeth Roemer (2004), takes a broader approach to ER by emphasizing the individual's perceived ability to regulate emotions rather than focusing on sequentially embedded strategies. The model emphasizes the extent to which the individual approaches emotions with acceptance, understanding, and tolerance; confidently employs effective and flexible strategies which align with situational demands and personal goals; and regulates impulses while maintaining a goal-directed behavior in emotional contexts (Gratz & Roemer, 2004). The relative absence of any or all of these abilities indicate ER difficulties. To operationalize their model of ER, Gratz and Roemer (2004) developed the DERS, a self-report measure for adults. This measure was later validated for adolescents (Neumann et al., 2010) and has since been used extensively in both clinical and non-clinical studies (Freitag et al., 2023). Findings generally show that greater ER difficulties, as measured by the DERS, are associated with a range of youth psychopathologies, including anxiety (Bender et al., 2015), OCD (Yazici & Yazici, 2019; Öztürk et al., 2023), depression (Daros et al., 2021), personality disorders (Gratz et al., 2018), ADHD (*parent-report*, Bunford et al., 2020), autism spectrum disorders (McVey et al., 2022), and eating disorders (Stewart et al., 2021).

A multi-operationalization of emotion regulation difficulties

While the two models are distinct in their origin (basic affective science vs. clinical research) and focus (strategies vs. abilities) (Hallion et al., 2018), it has been suggested that they are in fact interrelated (Tull & Aldao, 2015). Both models conceptualize ER as more than eliminating, controlling, or reducing negative emotions, and stress the role of context and the individual's goal in evaluating the adaptiveness of strategies and responding. Tull and Aldao (2015) illustrate this interplay with a bidirectional feedback loop in which ER strategies and abilities may influence each other positively and negatively. In the context of ER difficulties, the implementation and effectiveness of strategies likely depend on the individual's belief in their ability to manage emotional experiences, with lower self-efficacy leading the individual to rely more on maladaptive strategies such as avoidance or suppression. However, maladaptive strategies may in turn prevent the individual from fully engaging with negative emotions, thereby limiting the potential to build acceptance and tolerance over time.

Summary

ER is a multifaceted construct with no single definition. In this thesis, I integrate the process model of ER and the multidimensional model of ER. These two prominent models of ER are operationalized through complimentary measurements: the Tangram Emotion Coding Manual (TEC-M) to clinically evaluate ER strategies and the DERS to assess self- and parent-reported deficits in perceived ER abilities. By combining these measures, I aim to advance ER research in pediatric OCD by embracing the complexity of the construct rather than reducing it. This multi-operational approach provides a more nuanced understanding of ER, allowing us to address gaps in the existing literature.

Measuring emotion regulation

Given the complexity of ER and the dynamic systems involved, multi-informant and multi-method assessments are widely advocated for evaluating childhood ER (Althoff & Ametti, 2021; Freitag et al., 2023). However, such approaches remain largely underused. In their review on ER across childhood and adolescence, Adrian et al. (2011) analyzed 157 studies and found that only 23.6% employed two methods (e.g., self- and other-reports). This proportion decreased substantially with only 10.8% using three methods and a mere 4.5% incorporating four methods. To address the lack of multi-modal research, this thesis employs all four main approaches for evaluating childhood ER: 1) self-reports, 2) parent-reports, 3) behavioral observations, and 4) psychophysiological assessments. Thus, the following section provides a brief overview of each approach, emphasizing their applicability, strengths, and limitations.

Questionnaires

Questionnaires, including self- and parent-reports, are widely used to measure ER in children and adolescents. In 2011, Adrian et al. reviewed the literature extracting 42 questionnaires to assess pediatric ER, a decade later Freitag et al. (2023) extracted 115 questionnaires. While highlighting the explosive growth in the interest on pediatric ER, it also urges researchers and clinicians to be intentional when selecting a questionnaire. Questionnaires offer several advantages: they are easy to administer, feasible in clinical practice, and, given that the construct of interest is closely related to internal processes, it is useful to gather responses directly from the individual involved, as is done with self-reported outcomes. However, accurately reporting on one's own ER abilities requires meta-cognitive resources not yet fully matured during childhood (Cole & Hollenstein, 2018). Thus, most questionnaires targeting ER in younger children rely on parent-

reports (Mazefsky et al., 2021). However, they also present with biases, which can impact the rating of the child's ER abilities (Althubaiti, 2016). These biases include, but are not limited to, the ability to accurately remember how the child regulates emotions (recall bias) or the likelihood of portraying one's child as either better or worse at regulating emotions for the sake of a desired outcome (social desirability bias). Additionally, self- and parent-reports may not align in their reporting of ER (De Los Reyes et al., 2015). While not in itself alarming, this highlights that including another level of analysis may prove informative.

Behavioral observations

Behavioral observations may offer an alternative approach to the biases inherent in self- and parent-reports. Here, again as with questionnaires, choosing what measure to use rely on the concept of ER and the outcome desired to measure. Most studies rely on inducing emotional arousal, which the child must regulate (deliberately or spontaneously) to master the task (Young et al., 2019). The plethora of measures include tasks taxing blocked-goal attainment, response inhibition, emotional flexibility, conflict resolution, stress tolerance, and impulse control (Barrett et al., 2007). One challenge is that certain tasks may be more appropriate for specific age groups. For instance, tasks preventing a child from obtaining a desired toy may be more suitable for younger children, whereas tasks requiring emotional flexibility may be too challenging for this age group, as they require more advanced metacognitive skills. Additionally, there is often a gap between the controlled laboratory setting and real-life ER, which complicates the ability to draw ecologically valid conclusions. However, tasks that involve a parent may offer greater ecological validity, as they more accurately reflect the social context in which a child's ER typically unfolds (Gardner, 2000).

Psychophysiology

Peripheral psychophysiological correlates of ER include various measures, such as pupil dilation, facial electromyography, skin conductance, and cardiac and respiratory measures of HRV (Young et al., 2019). In our research, HRV was selected as the physiological measure and is therefore the focus of this section. HRV is a low-cost, accessible, and easy-to-use method compared to other psychophysiology measures, making it ideal for data collection during tasks in social contexts, which arguably provides better ecological validity for assessing ER in children and adolescents. HRV captures the fluctuation of heartbeats over time and reflects the dynamic interplay between the sympathetic and parasympathetic branches of the autonomic nervous system (Appelhans & Luecken, 2006). This regulatory process is thought to be facilitated by a functional network of brain structures, primarily through the vagus nerve, which promotes relaxation and recovery by

slowing the heart rate (Laborde et al., 2018). A substantial body of research demonstrates that children and adolescents with internalizing and externalizing disorders exhibit lower resting-state HRV compared to non-clinical peers (Beauchaine et al., 2007; Chen et al., 2023; Koenig et al., 2016). Lower resting-state HRV has also been linked to ER difficulties (Ametti et al., 2022; Bellato et al., 2024; Bunford et al., 2017; Deutz et al., 2019). While a detailed mechanistic explanation of the proposed autonomic relationship between psychopathology and ER difficulties is beyond the scope of this thesis, existing theories suggest that insufficient top-down regulation of the vagus nerve through cortical-subcortical pathways may underlie these associations (Porges, 2001; Thayer & Lane, 2000). Notably, links between HRV reactivity and psychopathology and HRV reactivity and ER difficulties in children and adolescents have received little attention and the findings are not consistent (Beauchaine & Bell, 2020). Finally, despite its popularity, the specificity of HRV to psychological constructs like ER is still debated, complicating the functional interpretation of observed differences (Kreibig, 2010).

Summary

While each type of ER measure has its limitations, incorporating multiple methods and recognizing their individual constraints can provide a more comprehensive understanding of ER and significantly advance research in this field.

Development of emotion regulation and its role in pediatric psychopathology

The ability to adaptively regulate emotions develop with age through a complex interplay between biological, cognitive, behavioral, and social processes (Perry & Calkins, 2018). Understanding the typical development of ER is essential for clinically assessing when, how, and why ER may become disrupted or dysfunctional. This section first examines the progression of ER in typically developing children and then explores how abnormal ER plays a central role in pediatric psychopathologies. Finally, the relevance of two studies included in this thesis (the referral and the DERS studies) is discussed in relation to the concepts of typical ER and ER difficulties in psychopathology.

Typically developing emotion regulation

From birth, children possess individual thresholds for reacting to various types and levels of stimuli (Crowell, 2021). While children are also innately equipped with some regulatory strategies, such as help seeking and attention diversion, they largely depend on their social environment, particularly their caregivers, for regulation and support in managing their emotional responding (Diamond & Aspinwall, 2003). As illustrated in **Figure 2**, throughout childhood and adolescence, regulatory components mature and become increasingly elaborate and complex, intertwining with the inherent reactive threshold, thereby making them more difficult to disentangle (Crowell, 2021). The development of ER in school-age children and adolescents continues to depend on caregivers support, however, peer relationships increasingly play a significant role in the socialization of ER, particularly through context-dependent display rules (Zeman et al., 2006). Throughout this period, children increasingly develop their abilities to self-regulate, refining their regulatory strategies, from more instinctive and intuitive approaches to more cognitively driven processes, which involve the appraisal of both short- and long-term goals (Crowell, 2021). Various intraindividual mechanisms influence the development of ER, such as the maturation of neural pathways (Casey et al., 2019; Perlman & Pelphrey, 2011), cognitive processes (Eisenberg et al., 2014), and hormonal changes (Yilmazer, 2024), many of which continue to evolve across the lifespan, paralleling the ongoing development of ER.

While the development of ER follows broad developmental trajectories, it is important to recognize that ER is highly dynamic and individual, with typical ER likely falling along a continuum (McRae et al., 2012). This variability presents challenges in assessing abnormal ER, particularly when the scope does not necessarily involve extreme dysregulation. To support both clinical and scientific interpretation, establishing reference intervals for typical ER on ER measures could be valuable (Schulte-van Maaren et al., 2013). These intervals would help define the range of scores representing typical ER for specific age groups, enabling clinicians and researchers to identify deviation from typical patterns and distinguish normal variations from those that may require intervention. Given that no norms or reference intervals for typical ER have been previously established for the DERS, the questionnaire used in the OCD studies, the primary aim of the DERS study was to define preliminary reference intervals.

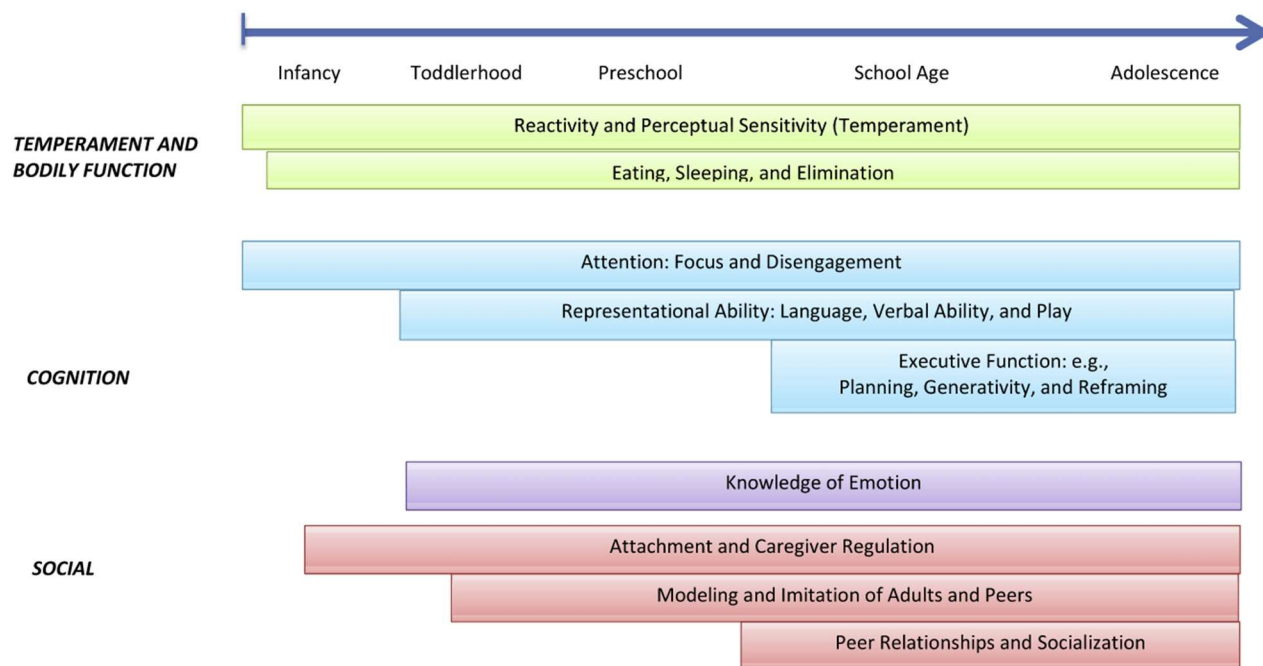


Figure 2. Influences on emotion regulation across development

The figure illustrates the key influencers on emotion regulation development across childhood stages. It highlights the role of inherent factors, such as temperament and bodily functions, in emotion regulation from infancy onward, while higher-order executive functions mature later, supporting more advanced emotional control. The figure emphasizes the gradual integration of these influences in development of emotion regulation. Figure from Crowell 2021. Copyright 2024, Elsevier. Reprinted with permission.

Emotion regulation in pediatric psychopathology

ER difficulties are widely recognized as central to the development and maintenance of various psychopathologies in children and adolescents (Aldao et al., 2016). These include internalizing disorders, such as anxiety and depression, and externalizing disorders, such as attention-deficit/hyperactivity disorder (ADHD) and conduct disorder (Aldao et al., 2016; Paulus et al., 2021). ER difficulties manifest in diverse ways that often interact with one other, including challenges in managing intense emotions, flexibly applying appropriate ER strategies, and effectively understanding and accepting one's emotional states (Aldao et al., 2010). While ER difficulties are well-documented both in established pediatric diagnoses and in studies assessing dimensional symptom severity in non-clinical populations (Schäfer et al., 2017), the prevalence and impact of ER difficulties as main concern in children and adolescents referred to Child and Adolescent Mental Health Services (CAMHS) remain unexplored. Addressing this gap in knowledge is significant for several reasons. First, understanding the role of ER difficulties in referrals may improve diagnostic accuracy and treatment planning. Second, it may inform the development of early interventions that address ER difficulties before they contribute to the onset or exacerbation of psychopathology. Finally, identifying ER as a central concern in mental health referrals could prioritize ER-focused interventions, improving outcomes

for children and adolescents. Thus, the primary aim of the referral study was to address this gap in the literature by clarifying the role of ER difficulties in pediatric mental health referrals.

Summary

ER develops through complex interactions between biological, cognitive, behavioral, and social processes. In typically developing children, ER evolves from caregiver support to gradually more self-controlled strategies. In pediatric psychopathology, ER difficulties are central to both internalizing and externalizing disorders, with children struggling to manage emotions, apply flexible strategies, and understand their emotional states. These challenges arguably contribute to the onset and persistence of mental health issues.

Obsessive-compulsive disorder in children and adolescents

Ritualized behaviors are part of normal development with a proposed evolutionary purpose of helping the individual cope in unpredictable social and environmental conditions (Tonna et al., 2020). However, when rituals become time-consuming, distressing, and disruptive of everyday functioning, they may meet the diagnostic criteria for OCD (Audet et al., 2023). In the following section, the clinical characteristics of OCD are reviewed, including its prevalence and impact. Additionally, the first-line psychological treatment is discussed. Finally, recent scientific advancements are examined, suggesting that OCD is linked to a complex emotional profile extending beyond anxiety and potentially associated with underlying ER difficulties.

Clinical characteristics, prevalence, and burden of OCD

Essential symptoms for a clinical diagnosis of OCD include pathological obsessions and compulsions (Stiede et al., 2024). Previously classified as an anxiety disorder (World Health Organization, 1992), OCD is now the primary diagnosis within the newly established category of Obsessive-Compulsive and Related Disorders, introduced in both the 11th revision of the International Classification of Diseases (ICD-11, 2019) and the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5, 2013). Both manuals define obsessions as recurring, intrusive thoughts, urges, or images that commonly induce anxiety, with DSM-5 also emphasizing associated distress. Compulsions are repetitive behaviors or mental acts performed in response to an obsession or to achieve a sense of completeness (Cervin, 2023).

While OCD is now recognized as more prevalent than previously perceived (Stein et al., 2019), lifetime prevalence estimates of pediatric OCD vary across studies. For instance, a UK cohort of children aged 5–15 years reported a prevalence of 0.25% (Heyman et al., 2001), compared to 1.3% in a Chinese cohort of children aged 6–16 years (Yan et al., 2022) and as high as 3% in a U.S. sample of adolescents and young adults aged 11–21 years (Barzilay et al., 2019). OCD in children and adolescents, like in adults, is often underdiagnosed and undertreated (Stahnke, 2021; Wahl et al., 2010), with research demonstrating significant delays between the onset of symptoms and the initiation of appropriate treatment (Walitza et al., 2011). This delay can be attributed to various factors, such as children concealing their symptoms or restricting them to the home due to shame or stigma, as well as limited insight into the nature of their symptoms (Geller et al., 2021).

In a recent consensus statement on early intervention for OCD, experts described it as one of the most costly and burdensome psychiatric disorders, with its negative impact extending across individual, familial, societal, and economic domains (Fineberg et al., 2019). The psychosocial burden of OCD includes reduced quality of life, disrupted emotional and social development, and heightened levels of family conflict (Stiede et al., 2024). While the societal and economic impacts of OCD have received less attention, a recent Swedish study of children aged 11–17 years found that OCD was associated with significantly higher healthcare costs, parental absence from work, and school productivity loss compared to a non-clinical control group (Lenhard et al., 2023). A similar economic burden was reported in a UK study (Kochar et al., 2023). The lack of timely identification and treatment of pediatric OCD likely exacerbates the overall burden of the disorder, as the duration of untreated illness in children and adolescents is one of the strongest predictors of OCD persistence over time (Micali et al., 2010).

Psychological treatment

Cognitive-behavioral therapy (CBT) with exposure and response prevention (ERP) has received robust empirical support as the recommended first-line psychological treatment for pediatric OCD (Cervin et al., 2024; Uhre et al., 2020; Öst et al., 2016). This treatment approach is grounded on the cognitive-behavioral model, which posits that obsessions themselves are not inherently problematic. Instead, it is the appraisal of these obsessions and their maintenance through negatively reinforced behaviors, such as compulsions and avoidance, that contribute to the disorder (Abramowitz et al., 2009). While these behaviors may provide short-term relief, they reinforce a vicious cycle that prevents the child from challenging the negative appraisals associated with the obsessions (Foa & McLean, 2016). This is likely leading to long-term consequences, including more frequent symptoms, increased avoidance, and the reinforcement of dysfunctional cognitive beliefs (Selles et al., 2020). CBT addresses the functional relationship between

obsessions and compulsions through ERP, which is considered the active mechanism of the treatment. ERP is a systematic approach in which the child is gradually encouraged to engage with situations, thoughts or objects that trigger their OCD-related distress, while refraining from compulsive behaviors and avoidance. Theoretical models of the mechanism of change during ERP emphasize habituation (Foa & Kozak, 1986) and tolerance (Craske et al., 2008) as key processes that help alleviate fear and distress.

Families are often entangled in pediatric OCD through a bidirectional relationship, where the child's symptoms and distress affect family dynamics, while family attitudes, in turn, influence symptom severity and treatment effectiveness (Storch et al., 2009; Wu et al., 2016). As a result, involving parents in the treatment of pediatric OCD is recommended. Such family-based CBT approaches integrate parent sessions, addressing factors such as family conflict and family accommodation (the extent to which family members change behaviors to adapt to the OCD) and developing strategies to help parents support their child in managing the OCD (Pagsberg et al., 2022; Piacentini et al., 2011; Thomsen et al., 2013).

Emotions in OCD

Until recently, anxiety was considered the primary emotion underlying OCD, largely due to the dominant cognitive-behavioral model, which emphasizes threat perception and threat appraisal as key mechanisms driving the disorder (Rachman, 1998; Salkovskis, 1999). As noted, the rationale from this model also underpins the first-line psychological treatment of OCD. However, a growing body of research suggests that emotions beyond fear and anxiety may also play a significant role in OCD, pointing to a more complex emotional landscape. Specifically, emotions such as shame (Laving et al., 2023), disgust (Cervin & Perrin, 2021; Knowles et al., 2016, 2018), incompleteness (Cervin et al., 2020, 2021; Cervin & Perrin, 2021), intolerance of uncertainty (Xu et al., 2024), anger (Barcaccia et al., 2022; Cludius et al., 2021), and irritability (Ezpeleta et al., 2022; Guzick et al., 2021) have been linked to various OCD-related domains, including symptom severity, functional impairment, family accommodation, and treatment outcomes. The more nuanced understanding of emotional experiences in OCD is accompanied by a broader view on OCD-related behaviors. In addition to avoidance and compulsions, traditionally seen as the responses to the emotional distress triggered by obsessions and their associated appraisals, behaviors such as temper outbursts, explosiveness, aggression, and disruptive behaviors are also commonly observed, particularly in children and adolescents (Guzick et al., 2021; Krebs et al., 2013; Lebowitz et al., 2015; McGuire et al., 2013; Storch et al., 2012). These emotional experiences and behaviors may indicate underlying ER difficulties to play a role in the manifestation and persistence of OCD.

Summary

OCD is a common and debilitating disorder that often has its onset during childhood and adolescence with significant impact across multiple domains. The recommended first-line treatment for children and adolescents is CBT with family involvement, which is based on the cognitive-behavioral model. This model conceptualizes anxiety as the primary emotion in OCD with maladaptive appraisals of the obsessive thoughts driving the disorder. However, recent research emphasizes a more nuanced emotional profile in OCD, including emotions such as disgust, shame, irritability, and incompleteness. This complex emotional interplay may stem from underlying difficulties in ER, which could contribute to both emotional experiences and behavioral expressions of the disorder. Consequently, exploring the relationship between ER difficulties and pediatric OCD may provide valuable insights into the underlying mechanisms of the disorder and guide the development of more effective treatments.

Emotion regulation difficulties in pediatric OCD

A recent systematic review by See et al. (2022) demonstrated a link between overall ER difficulties and greater obsessive-compulsive symptomatology (OCS), with distinct ER domains showing different relationships with specific obsessive-compulsive dimensions. While the review is informative, it mainly included studies with adult samples. Since ER abilities change across the lifespan (Zimmermann & Iwanski, 2014) and are highly context-dependent, with children's contexts differing significantly from those of adults, directly extrapolating findings on ER difficulties from adult to pediatric OCD is not recommended. Consequently, to gain an overview of the research on ER difficulties in pediatric OCD, I conducted a systematic literature search, following the approach by See et al. (2022) and incorporating search terms related to children and adolescents.

Systematic literature search on emotion regulation in pediatric OCD

The search was conducted on the 21st of November 2024, in PsychINFO and PubMed using the following search string adopted from See et al. (2022), applied to titles and abstracts:

((affect OR emotion) AND (regulat* OR modulat* OR control OR strateg* OR dysregulat* OR challeng* OR difficult*) AND (obsess* OR compuls* OR obsessive-compulsive disorder OR obsessive-compulsive disorder OR OCD) AND (child* OR youth* OR adolescen* OR pediatric OR paediatric))*

Studies were included if they were published in English, involved clinical or analogue samples up to the age of 18 years, and examined ER. Studies were excluded if they focused on emotion processing, expressions, or recognition. Finally, reviews and theoretical perspectives were excluded. To ensure comprehensive coverage, additional relevant literature was identified by screening reference lists of included studies. The aim of the search was two-fold: first, to review the current knowledge on ER difficulties in children and adolescents with OCD; and second, to examine the methods used to assess ER in this population.

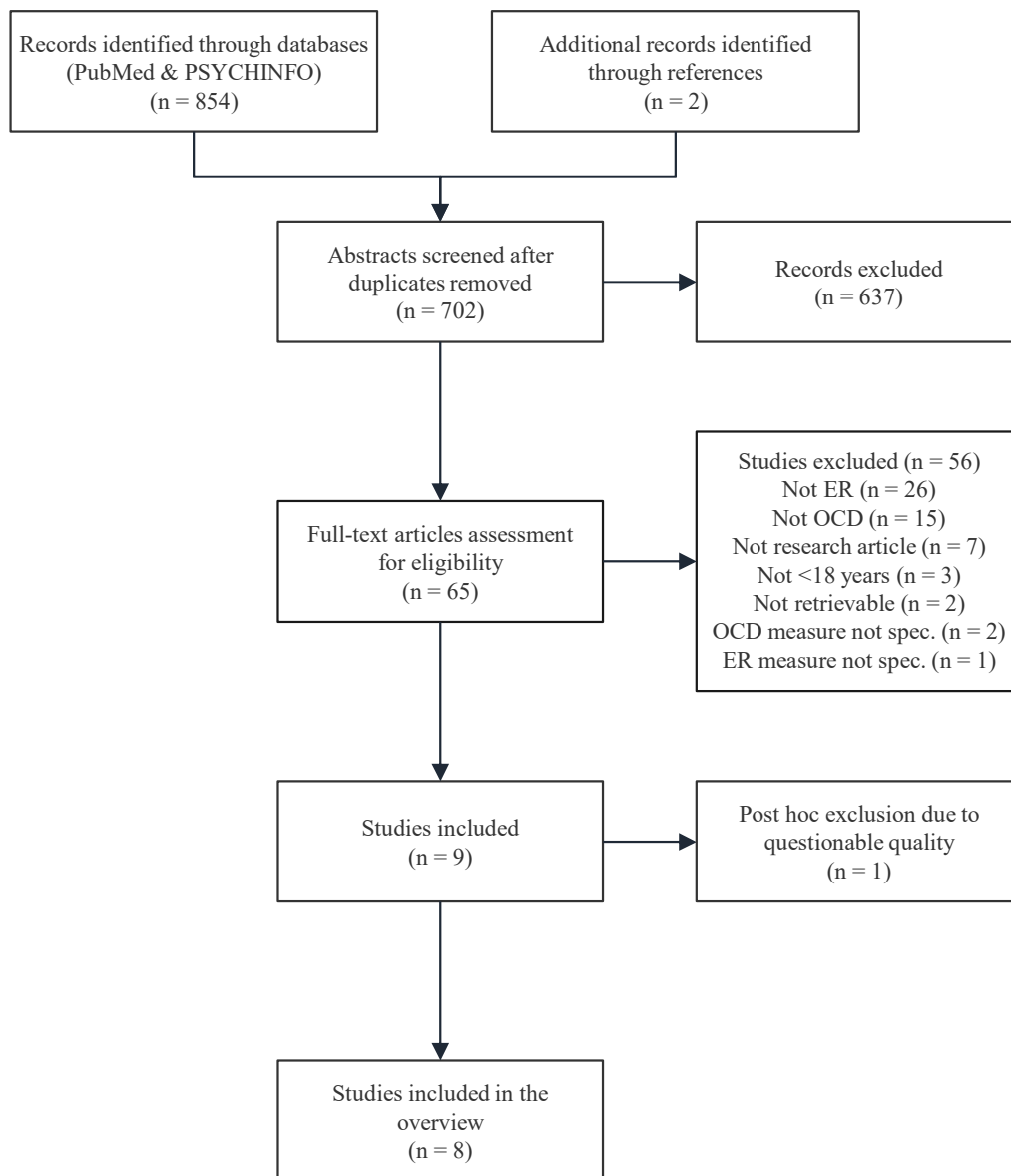


Figure 3. Flowchart of the systematic literature search.

Included studies are presented in Table 1.

Included studies

A total of nine eligible studies were initially extracted from the search (**Figure 3**). However, the study by Racz et al. (2024) was post hoc excluded due to methodological concerns, including non-comparability between patient groups, merging scales from distinct questionnaires and applying these scales to age groups for which they were not validated. Consequently, eight studies were ultimately identified as eligible and included in the overview (**Table 1**). With the exception of one study using a non-clinical sample (Ferrández-Mas et al., 2023), all studies determined clinical OCD diagnoses using semi-structured interviews, such as Kiddie Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version (K-SADS-PL). Additionally, all but one clinical study (Knowles & Tolin, 2024) used the Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS) to assess OCD symptom severity.

Table 1. Included studies from the literature search on emotion regulation difficulties in pediatric OCD

Authors	Year	Study design	Sample size	Mean age (SD)	Age range	ER measures	Responder	OCD measures	Other clinical measures	Relevant findings
McGuire et al.	2013	Longitudinal (CBT-ERP, varied dosing and format)	OCD (n = 144)	12.61 (2.81)	6-17 years	CBCL-DP	Parent-report	CY-BOCS	ADIS-C/P, CGI-I, FAS, COIS-P/C, MASC, CDI-S, CBCL	Youth with more ERD had greater OCD severity. ERD predicted more FA and impairment beyond OCD severity. ERD predicted treatment dropout but not response.
McNamara et al.	2014	Longitudinal (17 sessions of CBT-ERP + sertraline augmentation)	OCD (n=56)	11.7 (3.3)	7-17 years	BRIEF-EC	Parent-report	CY-BOCS	K-SADS-PL, SNAP-IV-P, CDSR-R, BRIEF	ERD moderated CBT-ERP outcomes - youth with more ERD exhibited less reduction in OCD symptom severity.
Yazici & Yazici	2019	Cross-sectional	OCD (n = 50); non-clinical controls (n = 50)	13.92 (1.83)	11-16 years	DERS-36	Self-report	CY-BOCS	K-SADS-PL, CDI, STAI-C, WISC-R	The OCD group had more ERD than controls. Youth with OCD and poor insight had most ERD. Youth with OCD and good insight still had more ERD than controls.
McKenzie et al.	2020a	Longitudinal (3 sessions of CBT-ERP+D-cycloserine augmentation)	OCD (n = 137)	12.18 (2.59)	7-17 years	BRIEF-EC	Parent-report	CY-BOCS	ADIS-IV-P, CBCL, FAS-SR	ERD was associated with greater OCD severity, more FA, and lower rates of CBT response and remission.
McKenzie et al.	2020b	Cross-sectional	OCD (n = 76)	12.48 (2.49)	7-17 years	ERC	Parent-report	CY-BOCS	ADIS-IV-P, CBCL, FAS-SR	ER was negatively related to externalizing symptoms, while liability/negativity was positively related to externalizing symptoms, FA, and moderated the association between OCD severity and FA.
Fernández-Mas et al.	2023	Cross-sectional	Student sample (n = 307)	14.78 (1.48)	12-18 years	CERQ	Self-report	OCI-CV		ER strategies showed complex links to dimensions of OCS, with planning, self-blame, and catastrophizing uniquely tied to overall OCS.
Öztürk et al.	2023	Cross-sectional	OCD (n = 42); non-clinical controls (n = 43)	14.52 (1.64)	12-18 years	DERS-36	Self-report	CY-BOCS	K-SADS-PL	The OCD group had greater overall ERD than controls, particularly in refocusing, using effective strategies, and accepting emotions.
Knowles & Tolin	2024	Longitudinal (15 sessions of CBT-ERP)	OCD (n = 55), SAD (n = 31), GAD (n = 19), Panic disorder (n = 10), Specific phobia (n = 5)	13.9 (n/a)	8-17 years	ERQ-CA	Self-report	MASC-2 obsessions and compulsions	DIAMOND-KID, MASC 2, CDI-2	The OCD group reported lower use of suppression at baseline. Neither suppression nor reappraisal at baseline predicted OCD symptom change after CBT, and both strategies remained unchanged after treatment.

Note. ADIS-IV-P = Anxiety Disorders Interview Schedule for DSM-IV, Parent Version; ADIS-C/P = Anxiety Disorders Interview Schedule for DSM-IV, Child and Parent Version; BRIEF = Behavior Rating Inventory of Executive Function; BRIEF-EC = Behavior Rating Inventory of Executive Function, Emotional Control; CBCL = Child Behavior Checklist-Dysregulation Profile; CBT-ERP = cognitive behavioral therapy with exposure and response prevention; CDI = Children's Depression Inventory; CDI-2 = Children's Depression Inventory, Second Edition; COIS-P/C = Child Obsessive Compulsive Severity; COIS-S = Clinical Global Impression-Severity; COIS-P/C = Parent/Child; CY-BOCS = Children's Yale-Brown Obsessive Compulsive Scale, Revised; CERQ = Cognitive Emotion Regulation Questionnaire; CGI-I = Clinical Global Impression-Improvement; CGI-S = Clinical Global Impression-Severity; COIS-P/C = Child Obsessive Compulsive Severity; COIS-S = Clinical Global Impression-Severity; COIS-P/C = Parent/Child; CY-BOCS = Children's Yale-Brown Obsessive Compulsive Scale, Revised; CERQ = Cognitive Emotion Regulation Questionnaire; CGI-I = Clinical Global Impression-Improvement; DIAMOND-KID = Diagnostic Interview for Anxiety, Mood, and Obsessive-Compulsive and Related Neuropsychiatric Disorders semi-structured interview—Child and Adolescent Version; ER = emotion regulation; ERC = Emotion Regulation Checklist; ERD = emotion regulation difficulties; ERQ-CA = Emotion Regulation Questionnaire for Children and Adolescents; FA = Family Accommodation Scale; FAS-SR = Family Accommodation Scale Self-report; GAD = Generalized anxiety disorder; K-SADS-PL = The Kiddie Schedule for Affective Disorders and Schizophrenia, Present and Lifetime Version; MASC = Multidimensional Anxiety Scale for Children – Second Edition; n/a = not applicable; OCD = Obsessive-compulsive disorder; OCI-CV = Obsessive Compulsive Inventory – Child version; OCS = obsessive compulsive symptomatology; SAD = Social anxiety disorder; SNAP-IV-P = Attention-Deficit and Hyperactivity Symptoms The Swanson, Nolan, and Pelham-IV-Parent Report; STAI-C = The State-Trait Anxiety Inventory for Children; WISC-R = Wechsler Intelligence Scale for Children-Revised Short Form.

Relevant findings

With respect to the first aim and in line with See et al. (2022), findings from the systematic literature search demonstrated links between ER difficulties and OCD in children and adolescents. Upon reviewing the studies, three main types emerged: (1) case-control studies; 2) studies relating ER difficulties to OCD-related functioning, and (3) treatment studies.

Case-control studies demonstrated that children and adolescents with OCD exhibited significantly greater global ER difficulties than non-clinical controls (Yazici & Yazici, 2019; Öztürk et al., 2023). Subscale analyses suggested that children with OCD experienced more difficulties in accepting negative emotions (Yazici & Yazici, 2019), as well as challenges with maintaining goal-directed behavior and confidently employing effective strategies when frustrated (Öztürk et al., 2023).

Within samples of patients with OCD, studies generally demonstrated that greater ER difficulties were associated with more severe OCD symptoms, higher levels of family accommodation, and greater child impairment (McGuire et al., 2013; McKenzie et al., 2020a). Notably, one study did not find an association between ER difficulties and OCD severity (McKenzie et al., 2020b). The only findings on dimensional OCS, coming from a non-clinical sample of adolescents, highlighted complex relationships between ER and OCS dimensions (Ferrández-Mas et al., 2023). However, I caution against directly generalizing results from this study to clinical populations.

Treatment studies, all employing various formats and dosages of CBT, including two, which augmented CBT with psychopharmacological treatments, provided mixed evidence regarding the role of ER in treatment outcomes. McNamara et al. (2014) and McKenzie et al. (2020a) found that greater ER difficulties at baseline was associated with poorer treatment response. In contrast, McGuire et al. (2013) did not find support for this association but instead found that baseline ER difficulties predicted treatment discontinuation. Further, McGuire et al. (2013) found ER difficulties to improve for those completing CBT. Investigating specific ER strategies, Knowles and Tolin (2024) found no changes in expressive suppression or cognitive reappraisal following CBT treatment, nor did baseline levels of these strategies predict improvement in self-reported OCD symptoms after treatment (Knowles & Tolin, 2024). Notably, none of the studies included a treatment control group to determine whether their findings were specific to CBT or reflected general treatment effects.

Methods used to assess emotion regulation in children and adolescents with OCD

With respect to the second aim, results from the eight included studies were all based on questionnaires. Cross-sectional studies relied more on self-reported outcomes, whereas treatment studies more frequently

used parent-reports. Each study employed a single measure to assess ER difficulties, with six different measures being used across the eight studies: Behavior Rating Inventory of Executive Function Emotional Control (BRIEF-EC), Child Behavior Checklist-Dysregulation Profile (CBCL-DP), Cognitive Emotion Regulation Questionnaire (CERQ), the DERS, Emotion Regulation Checklist (ERC), and Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA). Most studies adopted a broad definition of ER (McGuire et al., 2013; McNamara et al., 2014; Yazici & Yazici, 2019), while two studies focused on the use of specific strategies, such as cognitive reappraisal and suppression (Ferrández-Mas et al., 2023; Knowles & Tolin, 2024).

Summary

Our systematic literature search found that children and adolescent with OCD experience greater ER difficulties compared to non-clinical controls, and these difficulties are partially associated with OCD functioning. Treatment studies produced mixed results: some found that greater pre-treatment ER difficulties were linked to poorer treatment response, while others suggested that ER difficulties predicted treatment discontinuation. One study reported reduced ER difficulties for youths completing CBT, while another found no changes in ER strategies following treatment. These mixed findings likely reflect differences in study designs and treatment paradigms across studies. Finally, both cross-sectional and treatment studies relied solely on self- or parent-reported questionnaires with single-model conceptualizations of ER, which may limit the comprehensiveness of the findings.

Aims

The primary aims of this thesis was to examine the extent to which ER difficulties: (1) manifest across different modalities in children and adolescents with OCD before treatment, and (2) are implicated in treatment outcomes, specifically whether any effects are attributable to shared treatment elements or are specific to family-based CBT. These aims were investigated through two experimental studies (the OCD baseline and treatment studies).

Recognizing that ER difficulties are a transdiagnostic phenomenon affecting children and adolescents broadly, we conducted two additional studies to contextualize the findings from the OCD studies. In the first study, we examined ER difficulties in referrals to the CAMHC (the referral study). The primary aim of this study was to assess the frequency and types of ER difficulties that are most commonly identified as a main concern in children and adolescent referrals. In the second study, we estimated a reference interval for normative ER on the DERS (the DERS study). The DERS is the self-report measure employed in the OCD studies. Given this, and its widespread use, we aimed to define a threshold for normative ER to facilitate clinical and scientific interpretation of DERS scores by providing a benchmark for comparing individual patient scores against an expected normative value.

Chapter 2: Shared methods for the OCD studies

The following section outlines the methods employed in the OCD studies, which were part of a larger randomized clinical trial (TECTO). For methods in the referral and DERS studies, please see Chapter 3: Summary of studies.

This Methods section is organized into three parts: First, an overview of the TECTO design will be presented including the recruitment process, inclusion and exclusion criteria, clinical assessments, and the integration of sub-studies. Second, the design and assessments procedures specific to the ER sub-study will be discussed. Finally, ethical considerations and the statistical methods applied to the OCD baseline and treatment studies will be addressed.

The TECTO design

The TECTO trial aimed to compare the benefits and harms of family-based CBT (FCBT) including ERP with family-based psychoeducation and relaxation training (FPRT) in children and adolescents with OCD (Pagsberg et al., 2022). In addition to the trial design, the overall TECTO study incorporated a longitudinal case-control study that compared children and adolescents with OCD to a control group of children without any lifetime psychiatric conditions, thereby accounting for effects of normal development.

Recruitment

Children and adolescents were recruited from April 2018 to August 2022 with different recruitment procedures for the OCD and control group, as described below.

Children and adolescents in the OCD group

Children and adolescents with OCD were recruited in collaboration with the CAMHC. During the recruitment period, all children and adolescents aged 8 to 17 years from the Capital Region of Denmark, referred to CAMHC with suspected OCD, were evaluated by the specialized TECTO OCD team within the clinical outpatient services. Eligibility for inclusion was determined through standard clinical assessments

and clinical conferences with consultants or specialized psychologists in child and adolescent psychiatry. Parents or legal guardians of eligible participants were provided both verbal and written information about the trial during clinic visits and were subsequently contacted by phone. Upon consent, families were invited to attend two days of baseline assessments. Participants in the trial received a DKK 250 gift card as compensation for each research assessment day.

Children and adolescents in the control group

Children and adolescents in the control group were recruited via the Danish Civil Registration System, a national registry containing personal data on all permanent residents of Denmark (Pedersen, 2011). Randomized extracts were generated for children and adolescents aged 8 to 17 years from the Capital Region of Denmark. Children and adolescents in the control group were individually matched on age and sex to those in the OCD group, with a maximum age difference of three months. Parents or legal guardians of potential control participants received written information through a secure digital mailbox (e-Boks) and were contacted by phone at least three days later to address any questions and conduct a preliminary screening of exclusion criteria (see below). Potentially eligible children were then invited to attend a baseline assessment day, which mirrored the assessment day for the children and adolescents in the OCD group, except for clinical evaluations using the CY-BOCS. During this assessment, all children in the control group were evaluated to rule out the presence of exclusion criteria (see below). The assessments were conducted by trained psychologists, medical doctors, or graduate psychology students under supervision.

Inclusion and exclusion criteria

The inclusion criteria for all participants were age between 8 and 17 years (both included) and informed consent from parents or legal guardians. For the OCD group specifically, participants were required to have a primary diagnosis of OCD, as defined by the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10, World Health Organization, 1992) and with a CY-BOCS total score above 16.

The exclusion criteria for all participants included intelligence quotient (IQ) scores below 70 and treatment with CBT, PRT, or pharmacological treatments (antidepressant or antipsychotic medication) within the last six months prior to study entry. For the OCD group specifically, additional exclusion criteria included comorbid diagnoses of schizophrenia/paranoid psychosis, mania or bipolar disorder, depressive psychotic disorder, pervasive developmental disorder (except for Asperger's syndrome), or substance dependence

syndrome. For the control group, participants were excluded if they had any past or present psychiatric condition, as defined by the ICD-10 guidelines.

Participants

The final sample of the TECTO study included 220 children and adolescents aged 8-17 years from the Capital Region of Denmark, with 130 participants in the OCD group and 90 in the control group. Of the 130 participants in the OCD group, 64 were randomized to 14 sessions of FCBT and 66 to FRPT (**Figure 4**).

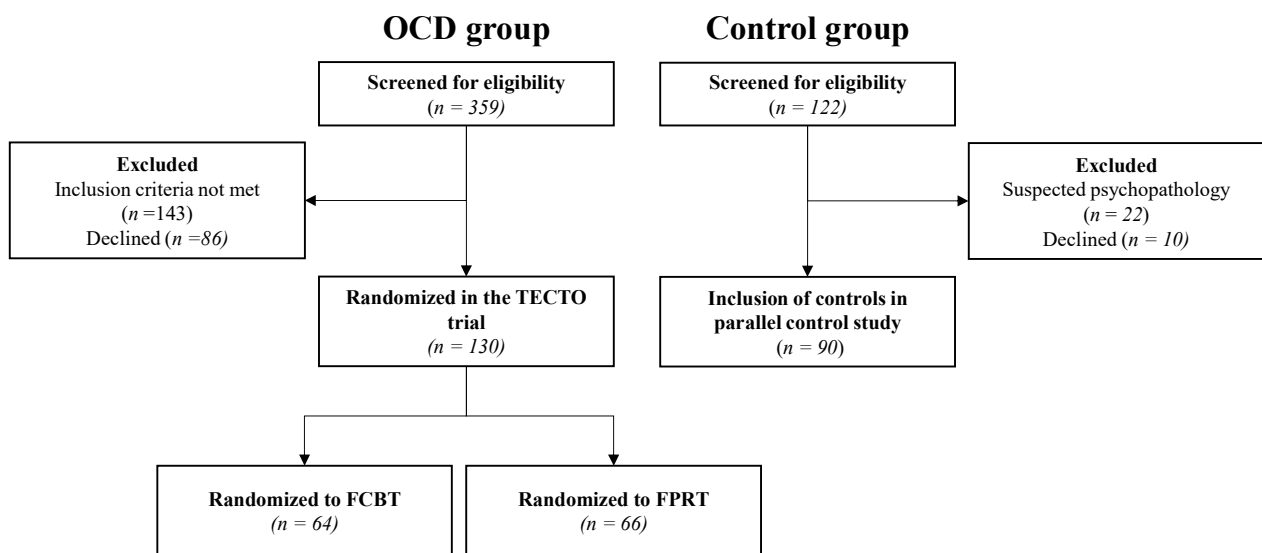


Figure 4. Flowchart of the TECTO study

Note. CY-BOCS = Children's Yale-Brown Obsessive Compulsive Scale; FCBT = Family-based cognitive-behavioral therapy; FPRT = Family-based psychoeducation and relaxation training; OCD = obsessive-compulsive disorder; TECTO = Treatment Effects of Family Based Cognitive Therapy in Children and Adolescents with Obsessive Compulsive Disorder. Reason for in-eligibility: No diagnosis of OCD (n=19); OCD not the primary diagnosis (N=39); CY-BOCS score < 16 (n=41); had a diagnosis according to exclusions criteria (n=13); WISC/WAIS<70 (n=3); had received treatment according to exclusions criteria (n=17); other (n=11).

Clinical assessments

All clinical assessments were conducted by a medical doctor, trained psychologist, or a graduate psychologist student under supervision. Both OCD and control group participants were administered the K-SADS-PL and IQ testing using the relevant Wechsler Scales. Only participants in the OCD group were administered the CY-BOCS.

Kiddie-Schedule for Affective Disorders and Schizophrenia, Present and Lifetime Version (K-SADS-PL)

The K-SADS-PL is a semi-structured diagnostic interview designed to assess the presence of current or lifetime symptoms of pediatric psychopathology according to criteria in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) (Kaufman et al., 1997). The interview consists of three parts (1) an introductory interview aimed at building rapport and identifying the main difficulties across various domains, including home, school, and social relationships; (2) the main interview, which covers the primary diagnostic categories for pediatric populations through a series of screening items; and (3) supplementary interviews for each diagnostic category, conducted when screening items reach the threshold for concern. The interview is conducted separately with parents and children, allowing the clinician to consider both perspectives and form a comprehensive clinical impression. In the TECTO study, we used the Danish version of the K-SADS-PL to establish the presence of inclusion and exclusion diagnoses. However, final clinical diagnoses were determined based on ICD-10 criteria, in accordance with the guidelines set by the CAMHS.

Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS)

The CY-BOCS is a gold-standard semi-structured interview designed to assess the type and severity of OCD symptoms in children and adolescents (Scahill et al., 1997). The interview includes a checklist of common obsessions and compulsions and evaluates the time spent on symptoms, the level of interference and distress caused, and the degree of resistance and control the child has over them. Severity ratings for each symptom range from 0 to 20. The total score, which combines the rating for obsession and compulsions, ranges from 0 to 40, with higher scores indicating more severe OCD symptoms.

Wechsler Intelligence Scales for children and adolescents

Age-appropriate Wechsler scales were used to assess intelligence in children and adolescents. The Wechsler Intelligence Scale for Children, Fifth Edition (WISC-V) was used to evaluate IQ in children and adolescents aged 8-16 years and 10 months, while the Wechsler Adult Intelligence Scale, Fourth Edition (WAIS-IV) was used for adolescents from the age of 16 years and 11 months or older. In accordance with standard clinical practice at the CAMHC in Denmark, full-scale IQ was assessed by a psychologist using ten subtests that measured five primary indexes: Verbal Comprehension, Visual Spatial, Fluid Reasoning, Working Memory, and Processing Speed. The full-scale IQ has a mean of 100 and a standard deviation of 15.

Interventions

The interventions employed in the TECTO trial are FCBT and FPRT. Both interventions were manualized, with FCBT based on the protocol by Thomsen and Weidle (2015) and FPRT based on the approach outlined by Piacentini et al. (2011). Each intervention consisted of 14 sessions, each lasting 75 minutes, delivered over a 16-week period. While both interventions incorporated family participation, psychoeducation, and homework assignments, their primary focus differed: FCBT emphasized ERP, whereas FPRT used muscle relaxation techniques and breathing exercises. Therapists were trained to administer both interventions, and external fidelity ratings were conducted to assess manual compliance, competence, and differentiation (Pagsberg et al., 2022).

TECTO sub-studies

The five sub-studies in TECTO aim to explore various factors potentially influencing the etiology, maintenance, and therapy processes of OCD. These factors include neurobiological, cognitive, neuroendocrine, psychotherapeutic, and emotional aspects, with the latter being the focus of this thesis.

Emotion regulation sub-study

The ER sub-study, involving the OCD baseline and treatment studies, was designed to investigate whether children and adolescent with OCD exhibited greater ER difficulties compared to non-clinical controls before starting treatment, and whether these difficulties play a role in treatment outcomes. In line with our conceptualization of ER and our aim to advance research through a comprehensive approach, the assessment of ER incorporated multiple modalities and informants. Due to later onset of ER assessments, 121 of 130 children and adolescents in the TECTO trial participated in the ER assessments, along with all 90 non-clinical controls.

Emotion regulation assessments

ER assessments were administered by psychologists or trained graduate psychology students under supervision. All measures presented below were included in the baseline OCD study, while only the self-

reported DERS was used in the OCD treatment study. For a visual presentation of the frustration paradigm, encompassing self-rated frustration, behavioral observation and psychophysiological indices, see **Figure 7**.

Difficulties in Emotion Regulation Scale (DERS)

The DERS is a self-report measure designed to assess the frequency of perceived ER difficulties (Gratz & Roemer, 2004). It consists of 36 items rated on a five-point Likert-scale from 1 (*almost never*) to 5 (*almost always*) providing a DERS total score ranging from 36 to 180 with higher scores indicating more difficulties. The 36 items are distributed across six subscales covering four broad aspect of ER (1) acceptance of emotions; (2) abilities to maintain goal-directed behavior and control impulses when distressed; (3) access to ER strategies perceived to be effective for feeling better; and (4) awareness and understanding of emotions. While originally developed for adults, the DERS has been validated for use with children as young as 11 years old (Neumann et al., 2010; Weinberg & Klonsky, 2009). In TECTO, the DERS was administered to children aged 11 years and older by a psychologist or graduate psychology student under supervision. Additionally, parents or legal guardians of children across the entire TECTO age range (8-17 years) completed a parent version of the DERS. This version was identical to the self-report version, except that it referred to “*my child*” instead of “*I*”.

Psychometric evaluation of the DERS total score in an adolescent sample (aged 13-17, N = 428) demonstrated strong internal consistency, with a Cronbach’s alpha of .93 (Weinberg & Klonsky, 2009). However, recent research on adult samples suggests that the subscale indexing emotional awareness may have lower factor loadings, indicating it might not align well with the other five subscales. Consequently, some studies recommend excluding this subscale to enhance conceptual consistency and reliability (Bardeen et al., 2012; Hallion et al., 2018). In the baseline OCD study, we chose to remove the emotional awareness subscale from analyses. However, in the OCD treatment study, we retained the subscale in the primary analyses of the DERS total score to align with current pediatric literature, where the exclusion of the subscale is not yet standard practice. Acknowledging the methodological concerns, we conducted secondary analyses of the DERS total score with the emotional awareness subscale removed.

Tangram Emotion Coding Manual (TEC-M)

The TEC-M is a clinical coding scheme designed to assess a child’s ER abilities during the Tangram Construction Task, a five-minute frustration task (Hagstrøm et al., 2019). The development of the TEC-M is based on Gross’ (2007) process model of ER. The five regulatory processes previously mentioned - situation

selection, situation modification, attentional deployment, cognitive change, and response modulation - guided both the selection of items included in the TEC-M and its overall structure (**Figure 6**).

During the Tangram Construction Task, the child is required to complete as many challenging puzzles as possible within five minutes, with one parent present. Before the task, the assessor shows the puzzle and the six pictures of possible figures that can be made with the Tangram pieces (**Figure 5**). The assessor then gives the following instruction: *“Look, here is a puzzle. With this puzzle you can make a lot of different figures. It is your job to make as many of these figures with these jigsaw pieces as you can during the next five minutes.”* The assessor then addresses the parent: *“You are here to support your child, but you are only to help if it is truly necessary. You get the solutions for you to see, but you are not to show them to your child.”* (Hagstrøm et al., 2019). This standardized instruction is used to minimize the influence of different instructions by different assessors. Following the instructions, the assessor leaves the room, and the entire five-minute task is videotaped for subsequent coding.

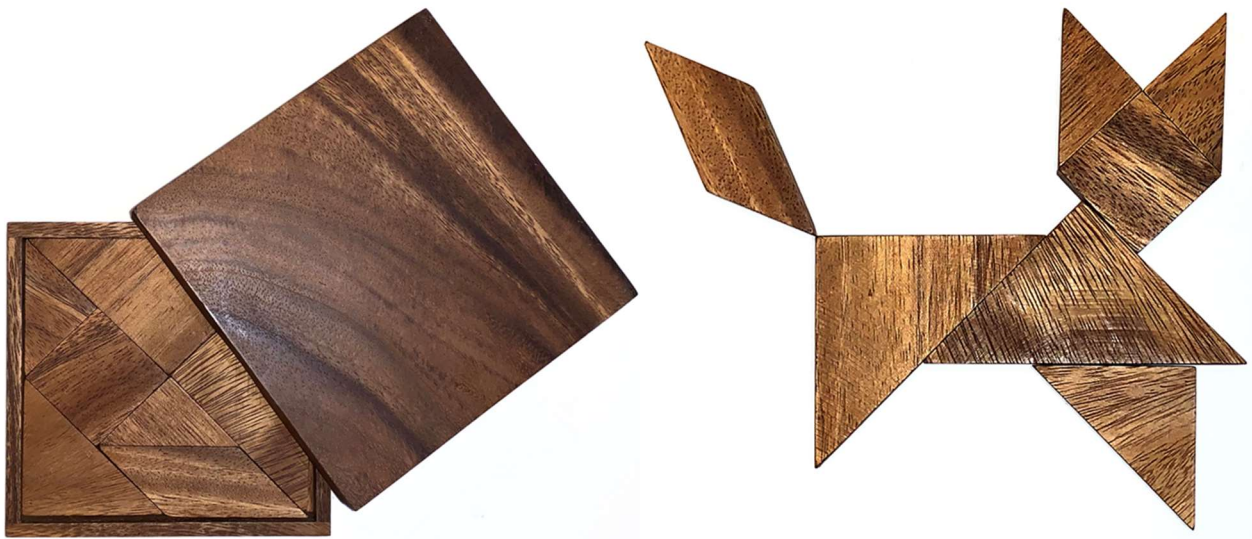


Figure 5. The Tangram Puzzle with figure example

The TEC-M includes 18 codes, categorized into four areas: eight items on parental behavior, eight items on child behavior, one item on the parent-child dyad, and the overall emotion regulation score (EmReg) (**Figure 6**). Items related to parental or child behavior or the dyad are scored on frequency (0 = Never, 1 = Rarely, 2 = Sometimes, 3 = Often) and intensity (1 = Mild, 2 = Moderate, 3 = Marked). The EmReg score is a qualitative composite score that reflects the child's overall ER abilities, considering contextual factors such as parental behavior. The EmReg is scored on a five-point scale with scores ranging from 1 (*very poor ER abilities*) to 5 (*excellent ER abilities*). The TEC-M has been validated for use with both clinical and non-clinical pediatric

samples (Hagstrøm et al., 2021; Spang et al., 2022). In the OCD baseline study, we used the EmReg score from the TEC-M as a behavioral measure of ER difficulties. Videos were coded by trained investigators. While no formal interrater reliability analysis was conducted, frequent consensus meetings were held to ensure coding consistency among investigators.

TEC-M Scoring Sheet							
Parent	The Tangram Construction Task	Intrusiveness			Verbal reappraisal		
		Control			Support sensitivity		
		Avoidance			Positive expressions		
					Negative expressions		
					Tension		
Situation selection		Situation modification		Attentional deployment		Cognitive change	
Response Modulation						Emotional warmth	
Child	The Tangram Construction Task	Control			Verbal reappraisal		
		Avoidance/resignation			Reassurance seeking		
		Narration			Positive expressions		
					Negative expressions		
					Aggression		
EmReg		1	2	3	4	5	
Frequency	Never 0	Rarely 1	Sometimes 2	Often 3	Notes:		ID:
Intensity		Mild 1	Moderate 2	Marked 3			Date:
							Coder:
							Test adm.:
							Time:

Figure 6. The TEC-M scoring sheet

The figure depicts the Tangram Emotion Coding Manual (TEC-M) sheet. The TEC-M includes 18 codes across four areas: parental behavior (8 items), child behavior (8 items), the parent-child dyad (1 item), and the overall emotion regulation score (EmReg) (Figure 6). Parental, child, and dyadic behaviors are scored on frequency (0 = Never, 1 = Rarely, 2 = Sometimes, 3 = Often) and intensity (1 = Mild, 2 = Moderate, 3 = Marked). The EmReg score is a qualitative composite reflecting the child's overall emotion regulation abilities, incorporating contextual factors such as parental behavior. The EmReg is scored on a five-point scale from 1 (very poor ER abilities) to 5 (excellent ER abilities). Figure courtesy of Julie Hagstrøm and Katrine S. Spang. For the development and validation of the TEC-M, see Hagstrøm et al., 2019.

Visual Analogue Scale (VAS)

The VAS was employed to assess self-rated levels of frustration in children and parents immediately before and after the Tangram Construction Task. Scores range from 0 (*no frustration*) to 10 (*highest level of frustration*), providing enough granularity to convey subtle differences in emotional states.

Heart Rate Variability (HRV)

We recorded the heart rate of both children and parents for five minutes before, during, and after the Tangram Construction Task. During the baseline and recovery periods following the task, both participants were instructed to sit still without communicating and to refrain from food and caffeinated beverages for at least two hours prior to the task. Heart rate data were collected using an electrocardiogram with the eMotion Faros 180° device (Mega Electronics Ltd., Pioneerinkatu, Finland). Two pre-lubricated disposable electrodes were placed on each participant—one just below the right clavicle and the other on the left side of the chest, beneath the 12th rib. While the sampling rate was set to 500 Hz for the OCD group, it was mistakenly set to 250 Hz for the control group. However, since 250 Hz sample rate is still sufficient for accurate HRV measurements, and given the subsequent interpolation of data, this discrepancy is not expected to impact the reliability or validity of the results (Quintana et al., 2016).

Three electrocardiogram (ECG) recordings were collected for each participant - before, during, and after task completion – resulting in a potential of 633 recordings from the 121 children and adolescents with OCD and 90 non-clinical controls. However, 78 recordings were missing due to various factors, including Covid-19, lack of informed consent for filming, and technical issues (for a detailed list of reasons for missing data, please refer to p. 3 in Supplementary Materials of the OCD baseline study). This left 563 recordings available for preprocessing.

Each ECG data file was imported into the Kubios HRV Scientific 4.0.2 software (Tarvainen et al., 2014). The data were interpolated at 2000 Hz and initially preprocessed using automatic R-peak detection based on the Pan-Tompkins algorithm (Tarvainen et al., 2014). A visual inspection was then performed on all 563 recordings to identify and correct any artifacts. Eight recordings were excluded due to insufficient data quality, leaving a final total of 555 ECG recordings for further analysis. Of these, 295 came from children and adolescents with OCD, while 260 came from non-clinical controls.

From the 555 recordings, three commonly used physiological measures were extracted (Laborde et al., 2017). The time-domain parameters included mean heart rate, measured in beats per minute, and the root mean square of successive differences of R-R intervals (RMSSD). For frequency-domain analysis, high-frequency HRV (HF-HRV) was calculated using the Fast Fourier Transform with Welch's Periodogram (window width = 300 s, 50% overlap, resampled at 4 Hz), with the HF-HRV band set at 0.15–0.4 Hz.

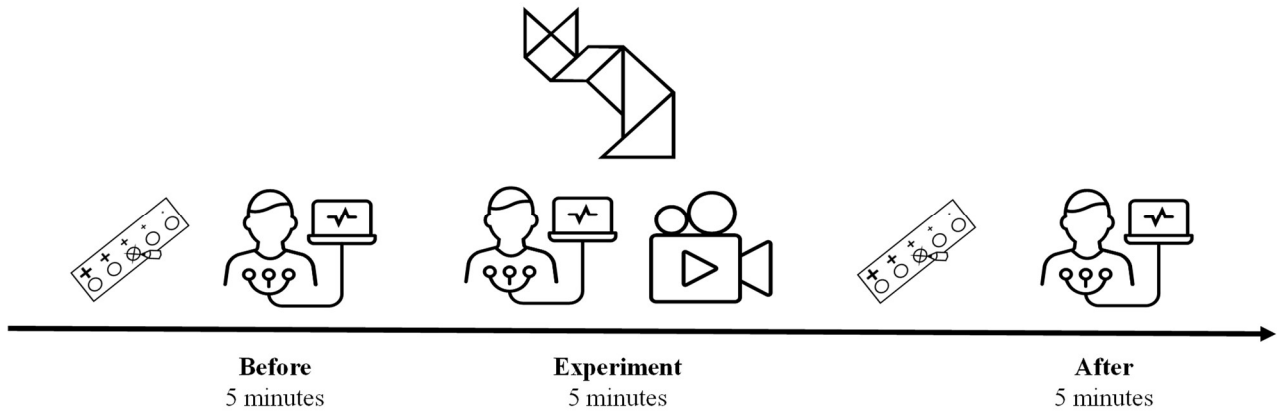


Figure 7. The frustration paradigm

The figure illustrates the frustration paradigm employed in the TECTO ER sub-study, comprising three stages: a baseline period with self-rated frustration and 5-minute electrocardiogram (ECG) measurement from child and parent, a task involving a 5-minute tangram frustration puzzle with concurrent ECG recording from child and parent, and a post-task phase with self-rated frustration and a 5-minute ECG recording with child and parent.

Ethical considerations and legal permits and approvals

The OCD studies were conducted in compliance with the Helsinki Declaration. These studies were approved by the National Research Ethics Committee (H-18010607) and The Knowledge Centre on Data Protection Compliance in The Capital Region of Denmark (VD-2018-263, I-Suite no.: 6502). Data were collected and stored in accordance with the Danish personal and health data regulations (the Danish Act on Processing of Personal Data, and the Danish health Act, Section 43, Subsection 1). The TECTO trial is furthermore registered on ClinicalTrials.gov: NCT03595098 (December 1, 2022). The Copenhagen Trial Unit (an external and independent party) randomized children in the OCD group, monitored the activities according to Good Clinical Practice, and handled the data management.

Statistical analyses

In the OCD baseline study, we employed several statistical models to assess differences in ER indices between children and adolescents with and without OCD: 1) multivariate analyses of variance to compare ER difficulties on self- and parent-reports respectively; 2) Student's *t*-test to compare investigator-rated behaviors; and 3) repeated measures analyses of variance to compare differences in self-rated frustration and HRV both between groups of children and adolescent with and without OCD and within each group across

tasks. All statistical models were carried out in SPSS version 28 (IBM Corp. Released 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp.).

In the OCD treatment study, we explored ER as treatment outcome, moderator, and mediator. To examine the effect of shared versus specific treatment elements, analyses were conducted in a two-fold manner: first, for all participants with OCD and second, by treatment allocation (FCBT vs. FPRT). To explore ER as treatment outcome, we used a paired t-test for all participants and linear regression to examine the effect of treatment allocation. Second, using a study-specific benchmark of normative ER, we evaluated changes in the proportion of adolescents with OCD reporting normative ER before and after treatment. This was done with a McNemar's mid p-test for all participants and a logistic regression model to account for treatment allocation. To explore ER as a moderator of treatment response, we conducted two linear regression models, one for all participants and one for treatment allocation. For ER as a moderator of treatment progress, we applied two mixed-effects models, again one for all participants and one by treatment allocation. Finally, to evaluate ER as a mediator of treatment response, we used the four-steps method proposed by Baron and Kenny (1986) for both all participants and by treatment allocation. All analyses were also repeated as sensitivity analyses, focusing only on treatment completers. All analyses were performed independently by two investigators, with one using SPSS version 29 (IBM Corp. Released 2023. IBM SPSS Statistics for Windows, Version 29.0.2.0 Armonk, NY: IBM Corp) and the other using R Statistical Software version 4.2.1 (R Core Team, Vienna, Austria).

Chapter 3: Summary of studies

This section provides an overview of the four studies included in the thesis, each exploring different aspects of ER in children and adolescents, spanning from typical development to clinical diagnoses. The referral and DERS studies, which offer contextual insights, are presented first, followed by the OCD baseline and treatment studies.

The section summarizes the background, aims, methods, and results of each study. For the OCD studies, the methods described in this section relates to the specific methods, samples, and focus used in each study. Significant findings (i.e., $p < .05$) are presented in the Results section, with non-significant findings available in the individual study manuscripts. Results will be discussed in **Chapter 4: General discussion**.

This section is not intended to be an exhaustive repetition of each study, which are fully presented in the final chapters of this thesis. Rather, it aims to bridge the Introduction (**Chapter 1**), which identified critical gaps in the literature, to the Main Findings and Discussion (**Chapter 4**), illustrating how these studies contribute to the understanding of ER in children and adolescents.

Study I: The referral study

For full details of this study see Ellehauge et al. (2023).

Background and aim

While ER difficulties are recognized as core features of many psychiatric disorders (Aldao et al., 2010), little is known about how often these difficulties drive families to seek mental health services. This is a significant gap in research as ER difficulties can create predisposing vulnerabilities for subsequent development of psychopathology, while psychopathology may, in turn, exacerbate ER difficulties (Gross & Jazaieri, 2014). Characterizing ER difficulties in treatment-seeking children and adolescents may offer valuable insights into early signs of psychopathology. This knowledge could ultimately enhance our ability to develop more effective preventive strategies and interventions. The referral study aimed to assess the prevalence and types of ER difficulties being a main concern when children and adolescents are referred to CAMHC (Ellehauge et al., 2023). To this end, we first examined ER difficulties in both accepted and rejected referrals, then assessed the associations between types of ER difficulties and sex and age, and finally, examined the most frequently occurring psychiatric diagnoses for children with ER difficulties (Ellehauge et al., 2023).

Methods

We conducted an exploratory retrospective chart review of referrals for children aged 3 to 17 years to the CAMHC, covering the period from August 1, 2020, to August 1, 2021. From the total pool of 7,718 referrals, a representative subsample of 999 referrals was extracted, ensuring proportional distributions of sex, age, and referral outcomes (accepted: 70.3%, rejected: 29.7%). Before data collection, we developed a manual and a coding scheme containing 72 keywords related to ER. These 72 words were grouped into eight overarching ER difficulty categories; 1) Incongruent affect; 2) Depressed mood; 3) Anxiety/worry; 4) Externalizing behavior; 5) Internalizing behavior; 6) Self-harm; 7) Difficulty regulating mood and emotions; 8) Emotion recognition. While these categories semantically resemble symptom descriptions, they serve as overarching labels in the referral study, encompassing predefined terms related to ER difficulties, such as discouraged, fragile, hypervigilant, out of control, and aggressive. For a full description on the terms included in each category, see Ellehauge et al. (2023), Appendix A. To identify a referral as describing ER difficulties, predefined ER terms were required to appear within a context that suggested such difficulties.

Each of the 999 referrals was coded for the presence (yes/no) of any of the 72 keywords, along with the three main concerns described in the referral. Additionally, for accepted referrals, we recorded any psychiatric diagnoses, which were made in reference to the referral. Group differences were examined between accepted and rejected referrals with regards to frequency of ER difficulties identified as main concern (primary, secondary, or tertiary), as well as the types of ER difficulty. Furthermore, group differences on ER difficulties in relation to age and sex distributions were assessed, as well as diagnoses associated with types of ER difficulties.

Results

Descriptive characteristics

There were no significant differences in age or sex between children and adolescents whose referrals were accepted ($n = 702$) and those whose referrals were rejected ($n = 297$). Examining the main concerns in referrals, we found symptoms of autism spectrum disorder (ASD), eating disorders, and inattention/hyperactivity to be most prominent in accepted referrals. In contrast, the most common concerns in rejected referrals were symptoms of inattention/hyperactivity, affective disorders, and ER difficulties.

Frequency and types of ER difficulties in rejected and accepted referrals

When investigating the frequency of ER difficulties in referrals to CAMHC, we found that ER difficulties were reported as a main concern in nearly two-thirds (62.3%) of all 999 referrals. While ER difficulties were almost equally reported as secondary and tertiary concerns in both accepted and rejected referrals, they were reported as the primary concern in twice as many rejected referrals (11.4%) compared to accepted referrals (5.7%) ($\chi^2(1,999) = 11.81, p = 0.003$).

There were no differences in the types of ER difficulties between accepted and rejected referrals among the 623 referrals where ER difficulties were a main concern. The most common categories were difficulty regulating mood and emotions (47.8%), externalizing behavior (43.3%), and depressed mood (42.8%).

Types of ER difficulties across sex and ages

Significant sex differences were identified in five out of eight categories of ER difficulties (**Table 2**). Boys were more frequently described as exhibiting externalizing behavior, internalizing behavior, and incongruent affect, while girls were more often described with depressed mood and self-harm. In terms of age (**Table 3**),

younger children more frequently exhibited externalizing and internalizing behaviors and difficulties in regulating mood and emotions, while adolescents more often engaged in self-harm. The types of ER difficulties with the least variability across age groups were anxiety/worry and depressed mood, both of which were reported in one-third to half of all children and adolescents referred. Emotion recognition was the rarest type of ER difficulty to be reported in referrals across almost all age groups.

Table 2. Sex differences in distribution of emotion regulation difficulties

	Male	Female	<i>p</i>	Adjusted ^a <i>p</i>
Incongruent affect, <i>n</i> (%)	49 (10.0)	24 (4.7)	0.002	0.012
Depressed mood, <i>n</i> (%)	186 (38.0)	242 (47.5)	0.002	0.012
Anxiety/worry, <i>n</i> (%)	170 (34.7)	176 (34.6)	0.968	0.968
Externalizing behavior, <i>n</i> (%)	272 (55.5)	161 (31.6)	0.000	<0.001
Internalizing behavior, <i>n</i> (%)	172 (35.1)	135 (26.5)	0.003	0.012
Self-harm, <i>n</i> (%)	46 (9.4)	121 (23.8)	0.000	<0.001
Difficulty regulating mood and emotions, <i>n</i> (%)	251 (51.2)	223 (43.8)	0.019	0.057
Emotion recognition, <i>n</i> (%)	34 (6.9)	25 (4.9)	0.174	0.348

This table presents sex differences in the proportion of emotion regulation difficulties across the eight different categories. Sex differences were assessed using a Holm-Bonferroni correction for multiple comparisons to control for type I error. Table from Ellehauge et al. (2023). Reprinted with permission through Creative Commons License.

Table 3. Age differences in distribution of emotion regulation difficulties

	3–5 years (<i>n</i> = 84)	6–8 years (<i>n</i> = 99)	9–11 years (<i>n</i> = 174)	12–14 years (<i>n</i> = 289)	15–17 years (<i>n</i> = 353)
Incongruent affect, <i>n</i> (%)	16 (19.0)	23 (23.2)	13 (7.5)	10 (3.5)	12 (3.4)
Depressed mood, <i>n</i> (%)	35 (41.7)	37 (37.4)	57 (32.8)	144 (49.8)	155 (44.3)
Anxiety/worry, <i>n</i> (%)	29 (34.5)	35 (35.4)	58 (33.5)	105 (36.3)	119 (34.0)
Externalizing behavior, <i>n</i> (%)	60 (71.4)	76 (76.8)	105 (60.7)	107 (37.0)	85 (24.1)
Internalizing behavior, <i>n</i> (%)	40 (47.6)	39 (39.4)	50 (28.7)	86 (29.8)	92 (26.0)
Self-harm, <i>n</i> (%)	7 (8.3)	12 (12.1)	18 (10.3)	66 (22.8)	64 (18.1)
Difficulty regulating mood and emotions, <i>n</i> (%)	54 (64.3)	69 (69.7)	89 (51.1)	123 (42.6)	139 (39.4)
Emotion recognition, <i>n</i> (%)	8 (9.5)	7 (7.1)	7 (4.0)	16 (5.5)	21 (5.9)

This table presents age differences in the proportion of emotion regulation difficulties across the eight different categories. Age differences were assessed using a Holm-Bonferroni correction for multiple comparisons to control for type I error. Table from Ellehauge et al. (2023). Reprinted with permission through Creative Commons License.

ER difficulties as main concern and subsequent diagnoses

For children and adolescents with ER difficulties as a main concern, ASD's were the most common diagnoses across all types of ER difficulties, except for the categories labelled incongruent affect and self-harm. Additionally, the five most frequently occurring psychiatric diagnoses in children with ER difficulties as a main concern were hyperkinetic disorders, stress reactions/adjustment disorders, and anxiety disorders consistently.

Summary

The primary objective of the referral study was to evaluate the frequency and types of ER difficulties reported as a main concern in referrals of children and adolescents to CAMHC. We found that ER difficulties were reported in over 60% of referrals and were identified as the primary concern in twice as many rejected referrals compared to accepted referrals. Moreover, identified ER difficulties varied by sex and age. Finally, ASD's, hyperkinetic disorders, stress reactions/adjustment disorders, and anxiety disorders were the most frequent diagnoses across all categories of ER difficulties. These findings suggest that ER difficulties may be considered a transdiagnostic factor, potentially independent of specific mental illnesses.

Study II: The DERS study

For full details of this study see Thoustrup and Olsen (2024).

Background and aim

ER difficulties are considered a critical factor transcending psychopathology across various diagnostic categories, influencing the onset, course, and severity of mental health disorders (Aldao et al., 2016; Fernandez et al., 2016). Studies predominantly assess ER difficulties using self-report measures, such as the DERS (Gratz & Roemer, 2004), which is among the five most used scales in clinical research (Freitag et al., 2023). Extensive research has demonstrated an association between higher DERS scores and mental health issues in adolescents (Neumann et al., 2010; Weinberg & Klonsky, 2009). However, a limitation in current clinical research is the absence of established normative thresholds for ER as measured by the DERS in adolescent samples (ages 11 to 18 years). This gap limits our ability to reliably interpret DERS scores and compare clinical groups to normative data, thereby restricting its applicability in clinical practice (Schulte-van Maaren et al., 2013). Therefore, the primary aim of this study was to establish a threshold for normative ER. To this end, we conducted a comprehensive literature search and estimated the 90% reference interval for the original version of the DERS (DERS-36), using scores from adolescents in community-based and non-clinical samples.

Methods

A systematic search was conducted on PubMed (MEDLINE) on March 12, 2024. Titles and abstracts were screened by the PhD student. Consistent with research on reference intervals emphasizing the inclusion of representative community samples (Schulte-van Maaren et al., 2013), we included both non-clinical and community-based adolescents. Inclusion criteria were: (1) empirical studies published in English; (2) studies involving adolescents aged 11 to 19 years, categorized as non-clinical or community-based participants; and (3) studies reporting total scores or scores from all 6 subscales from the DERS. Exclusion criteria were: (1) non-empirical studies; (2) studies not published in English; (3) studies including participants outside the specified age range; (4) studies reporting fewer than six subscales or using a short-form of the DERS; (5) studies relying on parent-reported outcomes; and (6) studies with insufficient reporting of statistical data. For consistency, mean scores were converted to summed scores, and subscale scores were aggregated to form a total score (DERS-T), falling in the range from 36 to 180 with higher scores indicative of greater ER

difficulties. Full-text articles deemed eligible were reviewed. If studies reported DERS at multiple time points, only baseline DERS scores were extracted. Means and standard deviations were weighted according to the sample size of each study. The 90% reference interval was then calculated by multiplying the standard deviation of the sample by a z-score of 1.645. As higher DERS-T scores indicate greater ER difficulties, results exceeding the reference interval (i.e. the top 5%) were classified as “abnormal”. In the absence of a designated lower threshold for the DERS-T, scores below the upper reference interval (the remaining 95%) were considered indicative of normative levels of ER.

Results

A total of 34 studies comprising 7,726 participants were included to estimate normative ER scores on the DERS. Of these, 20 studies included community-based participants ($n = 6,960$), while 14 studies included non-clinical participants ($n = 766$). For flowchart on the literature search, see Supplementary material p. 3 in Thoustrup and Olsen (2024).

Reference interval for all participants

The overall mean DERS-T score was 83.6 ($SD = 23.2$). The 90% reference interval across all participants ranged from 45.5 to 121.8. Accordingly, DERS-T scores below 121.8 indicate normative ER, while scores above this threshold is indicative of abnormal ER (**Figure 8**).

Reference intervals by group

Examining the DERS-T scores by group, we found that community-based participants had a mean score of 84.4 ($SD = 23.4$), with a 90% reference interval of 46.0 to 122.9. Non-clinical participants had a mean score of 76.5 ($SD = 20.0$), with a 90% reference interval of 43.6 to 109.4.

Reference intervals by sex

Of the 20 community-based studies, only 11 reported DERS-T scores by sex. Among these, girls had a mean score of 80.5 ($SD = 22.3$), while boys had a mean score of 75.6 ($SD = 18.6$). No studies on non-clinical participants provided sex-specific scores.

Summary

The primary aim of the DERS study was to establish a benchmark for normative ER in adolescents, based on scores from the DERS-36. However, after reviewing the existing literature, we identified a benchmark for normative ER as a DERS-T score of 121.8 or below. This finding is surprising, as a score of 121.8 exceeds the mean scores reported in most clinical studies. As will be discussed in **Chapter 4**, we are cautious about the utility of this benchmark and suggest that further research in this area is needed. Therefore, in the OCD studies, we included a sex- and age-matched control group to compare ER indices, including the DERS.

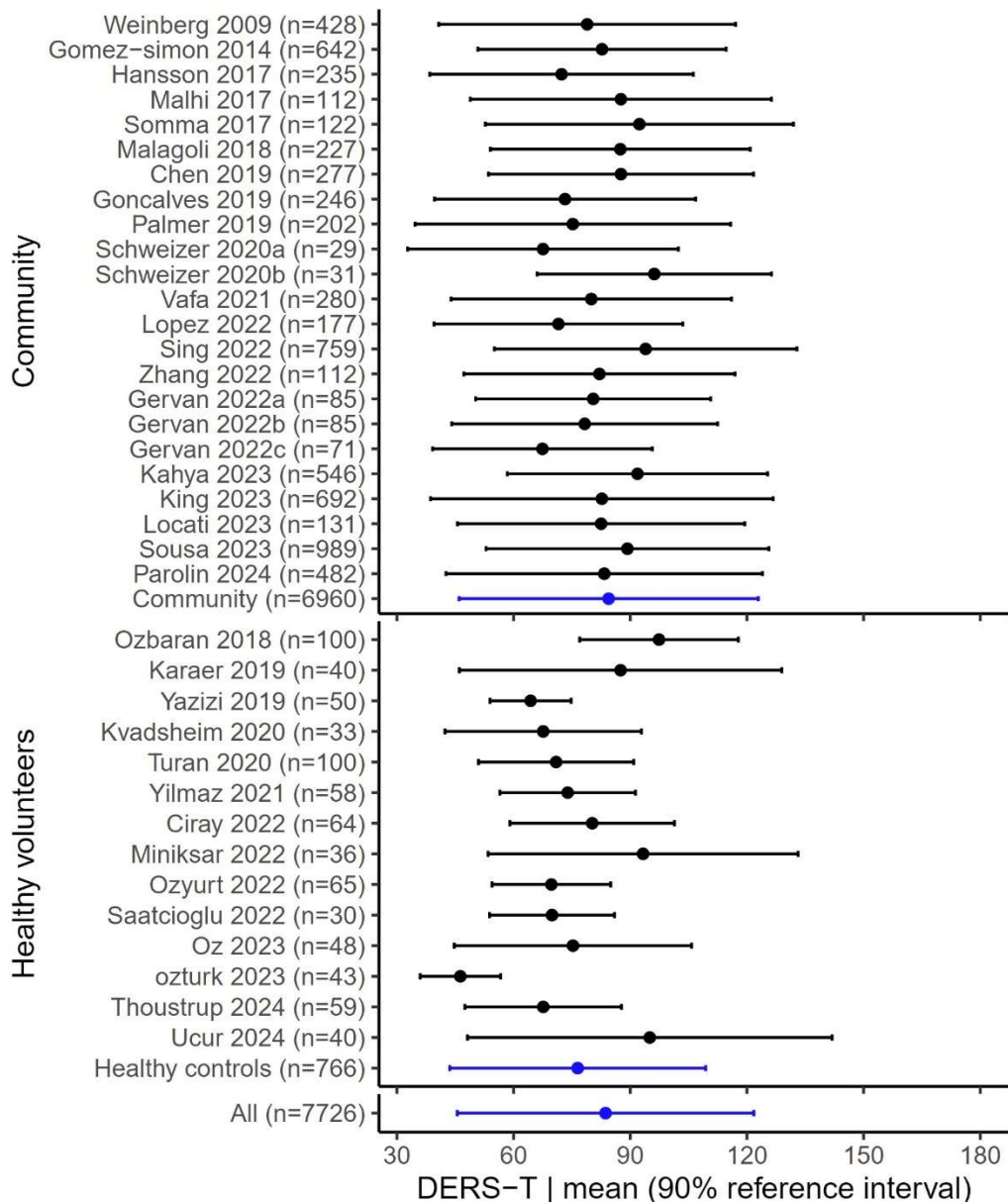


Figure 8. 90% reference interval of the DERS-T

The DERS-T = total score of the Difficulties in Emotion Regulation Scale (range 36 to 180). The reference interval for Community stems from studies using background population data including youths experiencing heightened levels of psychopathology. The reference interval for healthy volunteers stems from studies including youths as symptom-free and psychiatrically healthy. The black reference intervals represent the dispersion of DERS-T from individual studies. The blue reference intervals represent the combined dispersion from three groups respectively: Community-based samples (46.0-122.9), healthy volunteers (43.6-109.4), and all (45.5-121.8). Figure from Thoustrup and Olsen, (2024), reprinted with permission under CC BY-NC-ND 4.0 license (<https://creativecommons.org/licenses/by-nc-nd/4.0/>.)

Study III: The OCD baseline study

For full details on Study III, see Thoustrup et al., *manuscript under post-revision review*.

Background and aim

Previous research has established a link between pediatric OCD and ER difficulties; however, these studies have relied on questionnaires (McKenzie et al., 2020b; Yazici & Yazici, 2019; Öztürk et al., 2023). Recognizing the multi-dimensional nature of ER there is a need for more comprehensive investigations incorporating a variety of assessment methods. Such approaches would not only provide a more nuanced understanding of the relationship between pediatric OCD and ER difficulties but may also contribute insights for improving diagnostic practices and developing targeted intervention strategies. To address this gap, the present study examined pre-treatment difficulties in a group of children and adolescents with OCD compared to a non-clinical control group. The study employed a range of measures, including self-reports, parent-reports, behavioral observations, and psychophysiological indices, aiming to advance research on pre-treatment ER difficulties in pediatric OCD.

Methods

We included 211 children aged 8 to 17 years; 121 were treatment-seeking and newly diagnosed with OCD and 90 were non-clinical controls matched on age and sex. The children's ER difficulties were assessed with the DERS (self-reported and parent-reported) and a frustration task including behavioral observation (TEC-M), self-rated frustration (VAS), and HRV indices. Group differences between children with and without OCD were examined across all measures. Furthermore, we examined whether change in self-rated frustration and HRV measures differed within groups across conditions (before, during, after).

Results

Descriptive characteristics

Children with and without OCD were comparable in terms of age and sex, however, children without OCD had higher IQ scores ($p = <.001$, Cohen's $d = -.584$). Children in the OCD group demonstrated moderate to

severe OCD with a mean CY-BOCS total score of 25.96 ($SD = 4.96$), and 59.5% of these children were diagnosed with at least one comorbid disorder.

Self- and parent-reports

In terms of ER, children with OCD reported more difficulties across four out of the five subscales of the DERS compared to non-clinical controls ($p < .01$, $\eta_p^2 = .068-.165$). Additionally, parents of children with OCD reported greater ER difficulties in their children across all DERS subscales compared to parents of non-clinical control children ($p < .001$, $\eta_p^2 = .207-.369$).

The frustration task

Findings from the frustration task (**Figure 9**) suggested that children with OCD behaviorally exhibited more ER difficulties ($p = .026$, Cohen's $d = -.33$) and rated their frustration higher than non-clinical controls both before and after the task ($p = <.001$, $\eta_p^2 = .089$). Notably, the change in frustration ratings was comparable between children with and without OCD. Finally, while heart rate and HRV indices changed across the task for both groups ($p <.001$, $\eta_p^2 = .198$ to $.315$), no differences were observed between the children with and without OCD, neither at rest nor across conditions.

Summary

The findings of the OCD baseline study suggest a consistent pattern of children with OCD exhibiting greater ER difficulties across self-reports, parent-reports, and behavioral observations compared to non-clinical controls. However, psychophysiological indices did not substantiate significant differences between the two groups.

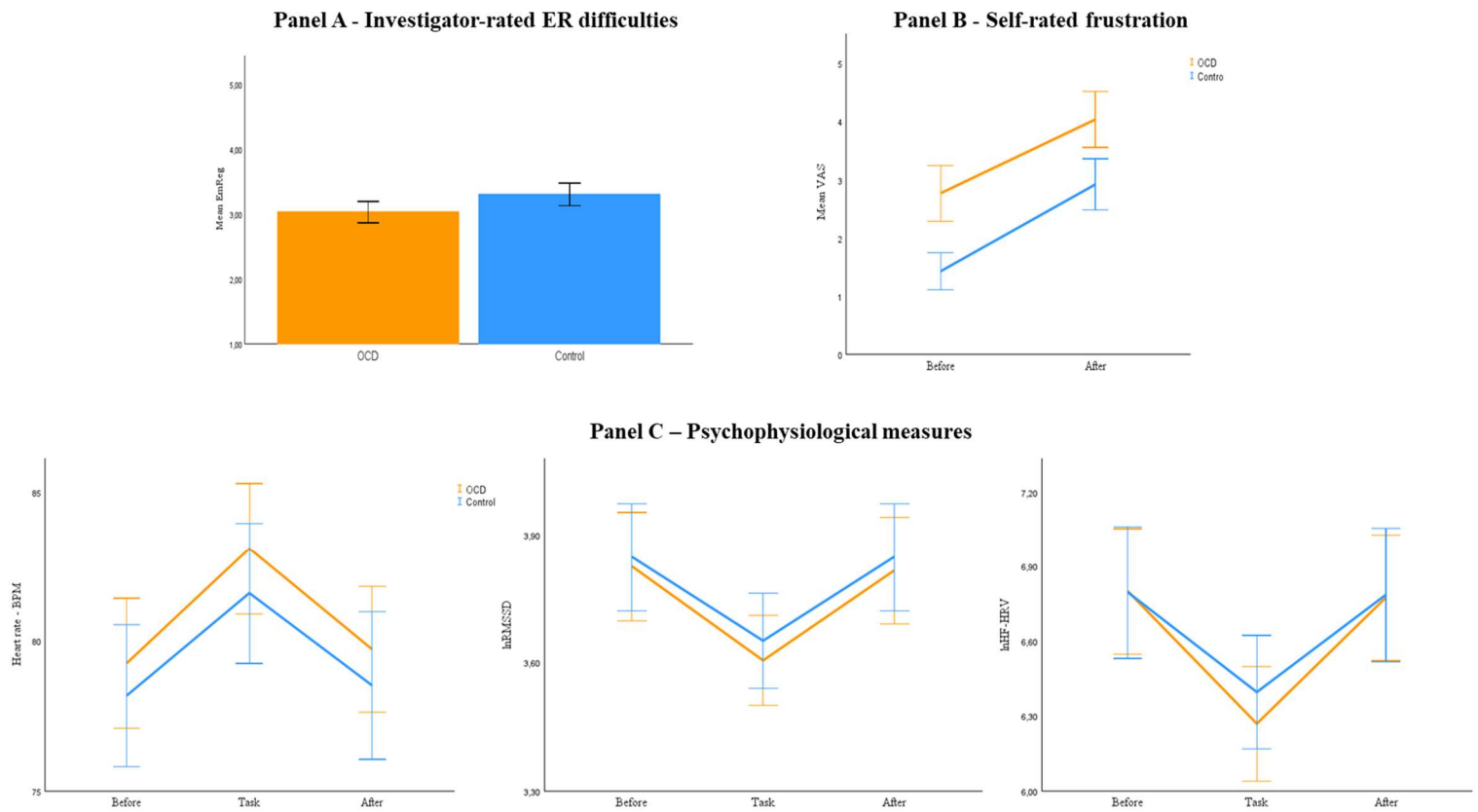


Figure 9. Results from the frustration task

Note. Panel A: group differences on the overall EmReg with higher scores indicating better emotion regulation abilities; Panel B: group differences and within-subject differences on self-rated frustration before and after the frustration task; Panel C: group differences and within-subject differences on HRV measures before, during, and after the frustration task. Error bars= SD. Abbreviations: BPM = beats per minute; EmReg = Emotion Regulation Scale; lnHF-HRV = the natural logarithm of high-frequency heart rate variability; lnRMSSD = the natural logarithm of root mean square of successive differences; OCD = obsessive-compulsive disorder; VAS = Visual Analogue Scale. Figure from Thoustrup et al., manuscript under post-revision review.

Study IV: The OCD treatment study

For full details on Study IV, see Thoustrup et al. *manuscript ready for submission*.

Background and aim

ER difficulties are suggested to play a significant role in pediatric OCD both prior to treatment and potentially in influencing treatment outcomes (McKenzie et al., 2020b, 2020a; McNamara et al., 2014). However, there is limited understanding of whether current interventions effectively target ER difficulties and whether these difficulties act as moderators or mediators of treatment outcomes, particularly across different types of intervention. While most research has concentrated on CBT, the first-line treatment for pediatric OCD, other interventions, such as those incorporating relaxation techniques, are also commonly used in real-world clinical practice (Reid et al., 2018). The aim of this study was to explore how ER difficulties are influenced by treatment and, in turn, how these difficulties impact treatment outcomes. Furthermore, the study examined whether these effects are related to shared therapeutic elements common to interventions (Helland et al., 2022), such as CBT and relaxation-based treatments, or whether they are specifically related to ERP, the proposed active mechanism of change in OCD treatment.

Methods

We included 79 adolescents with OCD, aged 11 to 17 years, who were randomized to 14 sessions of either FCBT or FPRT. Additionally, 59 sex- and age-matched non-clinical controls were recruited. Both clinical and non-clinical groups were assessed with the DERS at baseline and at end-of-study (16 weeks). Furthermore, adolescents with OCD completed the CY-BOCS at baseline, weeks 4 and 8, and at end-of-treatment. ER difficulties were assessed as treatment outcome, as well as moderator, and mediator in the OCD group. We pre-registered and published a combined protocol and statistical analysis plan prior to conducting the analyses (Thoustrup et al., 2025). First, the FCBT and FPRT groups were combined to examine shared therapeutic elements across interventions. Second, a comparison between treatment allocation was conducted to directly evaluate the impact of the ERP component. Sensitivity analyses were conducted using data from treatment completers (defined as those participating in at least 10 out of 14 sessions). Results from these analyses will be reported only if they differ from those of the main analyses.

Given the methodological concerns with the 90% reference interval derived from existing literature (Thoustrup & Olsen, 2024), we decided to use normative data from our non-clinical group to assess the

stability of ER difficulties over time and establish a study-specific benchmark of normative ER. This benchmark was then applied to evaluate changes in the proportion of adolescents with OCD reporting abnormal DERS scores from baseline to end-of-treatment.

Results

Descriptive characteristics

Adolescents in the OCD and non-clinical groups were comparable in terms of sex and age, but the non-clinical group exhibited higher IQ scores. Of the 79 adolescents with OCD, 37 were randomized to FCBT and 42 to FPRT. There were no differences between the treatment groups regarding sex, age, IQ, baseline CY-BOCS total scores, or the presence of at least one comorbid disorder. Additionally, ER difficulties were not associated with age in either the OCD or non-clinical group.

ER as treatment outcome

First, in the analysis combining the treatment groups, ER difficulties decreased from baseline to end-of-treatment (95% CI 4.95 to 16.15, $p < .001$). Second, treatment allocation impacted end-of-treatment ER difficulties after accounting for baseline ER difficulties and OCD symptom severity (95% CI -20.23 to -2.89, $p < 0.010$). This effect was driven by a reduction in ER difficulties in the FCBT groups (95% CI -25.63 to -8.19, $p < .001$), whereas no change was observed in the FPRT group.

Normative levels of emotion regulation at end-of-treatment

After confirming that ER difficulties did not change in the non-clinical group from baseline to end-of-study, we established the study-specific normative benchmark for ER as DERS scores below 90.59. In the analysis combining treatment groups, we found a decrease in the proportion of adolescents reporting abnormal scores from baseline (36.4%) to end-of-treatment (21.8%) ($p = .04$). However, this change was not observed when restricting the analysis to include treatment completers (completing 10 out of 14 sessions). Additionally, the likelihood of reporting ER within normative ranges at end-of-treatment was not influenced by treatment allocation.

ER as treatment moderator

ER difficulties did not moderate treatment outcome, as measured by the CY-BOCS at end-of-treatment, nor treatment progress, as assessed by the CY-BOCS at week 4, 8, and end-of-treatment, in either the combined analysis of treatment allocation or when comparing the treatment groups.

ER as treatment mediator

ER difficulties did not mediate treatment outcome, as measured by the CY-BOCS end-of-treatment, in either the combined analysis of treatment allocation or when comparing the treatment groups (**Figure 10**).

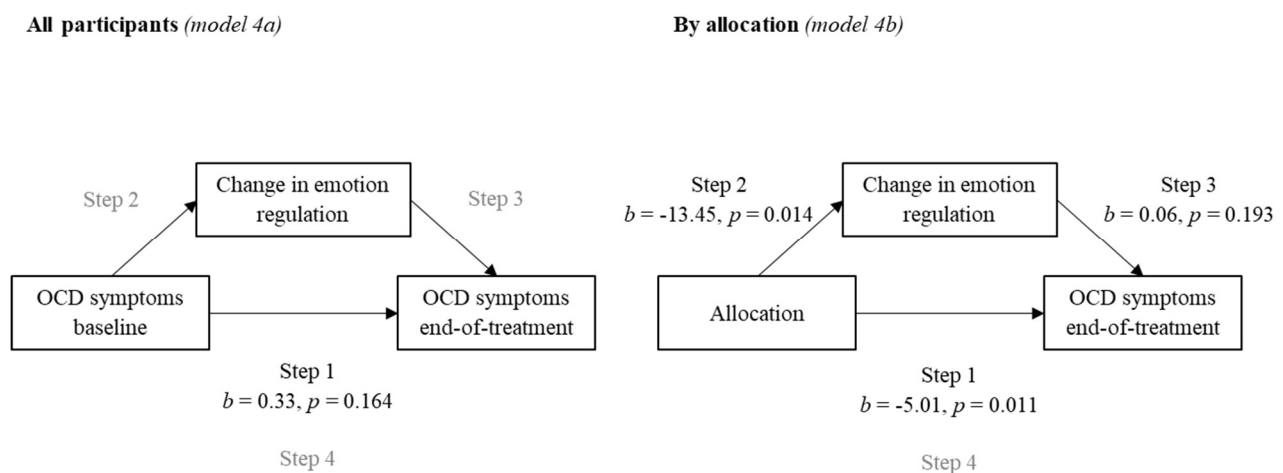


Figure 10. Emotion regulation as treatment mediator

Note. This figure illustrates Baron and Kenny's four-step mediation model: Step 1 regression of predictor on outcome; Step 2 regression of predictor on mediator; Step 3 regression of mediator on outcome (controlling for predictor); Step 4 regression of predictor on outcome (controlling for mediator). Only significant regressions are shown; non-significant steps are in the OCD treatment study, Supplementary material II, (pp. 11). OCD symptoms are measured by total score on Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS, range 0-40); Change in emotion regulation is based on T2-T1 of total score on Difficulties in Emotion Regulation Scale (DERS-T, range 36-180); Model 4a includes all participants with OCD ($N = 55$) and tests whether changes in emotion regulation difficulties mediate symptom change. Model 4b compares treatment groups: Family-based cognitive behavioral therapy (FCBT, $n = 29$) vs. Family-based psychoeducation and relaxation training (FPRT, $n = 26$). Treatment allocation is coded as FCBT = 1, FPRT = 0. Figure from Thoustrup et al., *manuscript ready for submission*.

Summary

The primary aim of the OCD treatment study was to explore ER difficulties as treatment outcome, moderator, and mediator in pediatric OCD psychotherapeutic treatment, with particular emphasis on whether these effects related to shared therapeutic elements or specifically to ERP. We found that ER difficulties decreased for adolescents receiving FCBT, but not for those receiving FPRT. Using a study-specific

benchmark for normative ER, we found a reduction in the proportion of adolescents reporting abnormal ER scores from pre- to post-treatment, with no significant effect of treatment allocation. Finally, we found no evidence that ER difficulties moderated or mediated treatment outcomes. These findings support ER difficulties as modifiable targets for therapy in pediatric OCD and suggest that FCBT is effective in improving ER abilities, whereas FPRT is not.

Chapter 4: General discussion

The current youth mental health crisis has prompted urgent calls from both the scientific and clinical communities for research into the factors contributing to the development and maintenance of youth mental health disorders (General (OSG), 2021; *The Lancet Psychiatry Commission*, 2024). Extensive research has identified ER difficulties as a transdiagnostic factor involved in a wide range of youth psychopathologies (Aldao et al., 2016; Dalgleish et al., 2017). However, several key issues remain:

First, the prevalence of ER difficulties as a main reason for referrals of youths to mental health services remains largely unexplored. While ER difficulties are often mentioned in clinical contexts, it is unclear how often they are part of the central concern driving families to seek professional help, particularly when examined through a diagnosis-agnostic approach.

Second, ER is inherently dynamic, context-dependent, and influenced by an individual's goals, making it challenging to define clear boundaries between normal and abnormal ER patterns (Cicchetti et al., 1995). This complexity complicates accurate assessment, particularly when severe dysfunction is not evident. One promising approach is to establish reference values for normative ER in measures employed in clinical settings (Schulte-van Maaren et al., 2013). Such values would help clarify the thresholds between normative and abnormal ER abilities, enhancing both the understanding and assessment of ER in youth mental health disorders.

Third, while ER evolves through the complex interaction of behavioral, biological, and social processes, most clinical research relies on single-model approaches and uses few measures, overlooking the multidimensional nature of ER (Adrian et al., 2011). This limitation is particularly evident in the context of pediatric OCD, a debilitating condition with profound personal, familial, and societal consequences. Despite growing evidence suggesting that pediatric OCD may be influenced by a complex emotional profile, potentially linked to underlying ER difficulties, current studies continue to rely on simplified assessment methods (See et al., 2022). Moreover, while preliminary evidence indicates that ER may impact treatment outcomes (McKenzie et al., 2020a; McNamara et al., 2014), little is known about whether this effect relates to general therapeutic elements or more specifically to ERP, considered the active ingredient in OCD psychotherapeutic treatment.

Incorporating more comprehensive, multi-faceted models of ER into research could better inform both assessment and treatment strategies, ultimately improving outcomes for youth with OCD and other related disorders. This thesis aimed to address these gaps in the literature.

Main findings, discussion, and future perspectives

In the following section, I will summarize the main findings from the four studies included in this thesis and discuss how they address some of the gaps in the literature. Throughout, I will discuss the clinical implications of the studies and propose potential directions for future research.

Emotion regulation difficulties in referrals (Study I)

In the assessment of 999 referrals to the CAMHC, we found that more than 60% of children and adolescents exhibited ER difficulties severe enough to be explicitly noted in their referral (Ellehauge et al., 2023). Notably, ER difficulties were the primary concern in twice as many rejected as accepted referrals, despite the two groups being comparable in terms of age and sex. This discrepancy may arise from the fact that ER difficulties do not always align directly with diagnostic criteria outlined in standardized diagnostic manuals (DSM-5, 2013; ICD-11, 2019). Recent research indicates that approximately one-third of referrals to another CAMHS in the Northern region of Denmark were re-referrals, defined as those initially rejected and subsequently made again at a later time, (Hansen et al., 2021), a finding consistent with research from the UK (Hinrichs et al., 2012) and Canada (Reid et al., 2019). This suggests that many children experience prolonged periods with unresolved mental health issues without receiving adequate support. Despite the substantial re-referral rates, there is a paucity of research on factors predicting re-referrals to CAMHS, which complicates efforts to improve early intervention strategies and ensure timely, effective care for these children. Building on our finding that ER difficulties as primary concern were more prevalent in rejected referrals and considering that these difficulties can predispose children to subsequent development of psychopathology (McLaughlin et al., 2011), we propose future research should explore whether children with ER difficulties who are initially rejected are later re-referred with more pronounced symptoms of psychopathology.

While the developmental trajectories of ER are highly idiosyncratic and context-dependent, research on typically developing children suggests a general pattern from early co-regulation with caretakers to increasingly internalized regulation, ultimately fostering greater independence (Crowell, 2021). In our referral study, the most notable age-related differences in ER difficulties were observed with younger children (aged 3-8 years) more frequently exhibiting externalizing behaviors, such as oppositional behaviors, temper outbursts, aggression, and irritability, compared to older children (aged 12-17 years) (Ellehauge et al., 2023). This finding is significant for several reasons.

First, it suggests that early mental health issues may be characterized by diffuse symptoms that do not yet align with specific diagnoses. These symptoms often remain generalized and are typically described by professionals referring the children using broader terms related to ER difficulties. As children develop and internalize their ER, it could be that problems with regulating emotions may crystallize into more specific psychopathological conditions. For example, excessive regulation of emotions, which is associated with inhibited behaviors and avoidance, may develop into internalizing difficulties, such as anxiety or mood disorders, whereas insufficient regulation of emotions, which is associated with impulsivity and risk-seeking, may manifest as externalizing problems such as ADHD and conduct disorders (Eisenberg et al., 2014; Steinberg, 2005). Moreover, similar to typical ER development, which progresses from external to internal regulation, it can be hypothesized that ER difficulties also undergo age-related changes, shifting from primarily external manifestations to more internalized forms (Zeman et al., 2006). These internalized difficulties may eventually manifest in maladaptive self-referential behaviors, such as self-harm, which we found to be notably more prevalent in adolescents compared to younger children (Ellehaug et al., 2023).

Second, externalizing behaviors observed in younger children often manifest most strongly in interactions with caregivers and significant others, emphasizing the importance of considering the family context when assessing ER difficulties, particularly in younger children (Zeman et al., 2006). Family dynamics may play an important role in both the expression and management of ER difficulties and previous research has demonstrated that parenting and attachment styles may influence children's externalizing problems (Deneault et al., 2022; Masud et al., 2019), although findings in this area are not entirely consistent (McKee et al., 2008). Additionally, studies indicate that stress within the family serves as a predictor for both an increased likelihood of child referrals and for parents perceiving their child's functioning as problematic (Gopalan et al., 2010; Verhulst & Der Ende, 1997). Future research should investigate the role of family functioning in the referral process for children with ER difficulties, focusing on how parenting and attachment styles influence the identification and management of these difficulties. Given that early ER difficulties can evolve into more defined symptoms of psychopathology, investigating the impact of family functioning on early detection and referral patterns is critical. Understanding these family factors may help identify opportunities for earlier intervention, ultimately improving outcomes for children at risk of developing more severe emotional and behavioral issues.

Estimating normative and abnormal emotion regulation (Study II)

While the DERS is widely used to assess ER difficulties in adolescents across both clinical and non-clinical studies (Cai et al., 2021; Çiray et al., 2022; Neumann et al., 2010; Öztürk et al., 2023), there is a lack of research providing guidance on how to interpret DERS scores. As a result, researchers and clinicians using

the DERS lack established cut-off scores or benchmarks to distinguish between normal and abnormal ER abilities. In the DERS study, we aimed to address this gap by establishing a reference point for interpreting DERS scores (Thoustrup & Olsen, 2024). Specifically, we aimed to establish a preliminary benchmark distinguishing normative from abnormal ER abilities in adolescents by estimating the 90% reference interval for normative ER based on existing literature.

From our literature search, we included 34 studies with a total of 7,726 participants aged 11 to 17 years, of which 6,960 were from community-based samples and 766 from non-clinical samples (Thoustrup & Olsen, 2024). While community-based samples may include individuals with heightened symptoms of psychopathology, non-clinical samples are specifically recruited to exclude individuals with such symptoms. From these studies, we estimated a 90% reference interval for the DERS-T ranging from 45.5 to 121.8. Given that the DERS-T ranges from 36 to 180, with higher scores indicating greater ER difficulties, we consider scores above 121.8 indicative of abnormal ER abilities.

This finding was unexpected as a DERS-T score of 121.8 is notably higher than the mean DERS-T scores reported in most clinical studies involving adolescents suffering from a broad range of psychopathologies, with the exception of some studies on personality disorders (Griffiths et al., 2019) and clinical samples with self-harm (Stewart et al., 2021). Studies on adolescents with anxiety (mean DERS-T = 86.52, Bender et al., 2015), depressive symptoms (mean DERS-T = 76.19, Gonçalves et al., 2019), and even ADHD (DERS-T mean = 108.92, Özbaran et al., 2018), a disorder in which ER difficulties are considered a core feature (Faraone et al., 2019), report DERS-T mean scores falling well below 121.8. While DERS scores from individual participants naturally deviate from the mean, and this benchmark therefore may offer some insights for interpreting these individual scores, we remain cautious about its broad applicability.

Several factors may account for the unexpected result. First, methodological considerations: While we aimed for standardized reporting by selecting only studies that included either a DERS-T score or all six subscales for subsequent aggregation, we could not account for the fact that many of the included studies did not report how they handled missing data and outliers. These factors may have influenced the estimates (Eekhout et al., 2012; Zijlstra et al., 2011). Further, despite recommendations to remove the awareness subscale due to its unsatisfactory psychometric properties (Bardeen et al., 2012), we chose to retain it in our analysis. This decision was made in recognizing that most research on adolescents does not follow these recommendations. By estimating the reference interval using the original 36-item DERS, we aimed to represent the general research landscape; however, this approach may have introduced additional variability, particularly if the awareness subscales in the included studies did not adequately load onto the overall factor structure.

Second, in addition to methodological considerations, the wide reference interval for the DERS-T and the high benchmark for abnormal ER may reflect that ER exists on a continuum (Steinberg, 2005). While the benchmark seeks to categorize ER difficulties for easier interpretation of the DERS, these difficulties are not

discrete; rather, they span a broad spectrum, even within non-clinical populations (Cai et al., 2021). This variation may be particularly relevant in adolescents, as research suggests that the biological and neural processes underlying ER during this period develop in a non-linear way (Steinberg, 2005). Behaviorally, these non-linear trajectories are suggested to contribute to impulsivity, increased risk-seeking behaviors and the usage of maladaptive ER strategies, specifically between the ages of 12 to 15 years (Cracco et al., 2017). To account for developmental variation and the observed sex differences in the reference interval, with girls reporting greater overall ER difficulties than boys, a logical next step in developing interpretive guidelines for the DERS would be to establish age- and sex-adjusted norms. These adjustments would allow for more precise comparisons by controlling for developmental and sex-related differences, thereby enhancing the accuracy and relevance of the DERS in diverse populations. While similar efforts have been taken with the DERS-36 in adults (Giromini et al., 2017) and a short form of the DERS (DERS-16) in adolescents (Stivaletti Colombaroli et al., 2022), there remains a notable gap in research applying age- and sex-adjusted norms to the original DERS-36 in adolescent samples. Addressing this gap is essential for improving both the clinical utility and interpretive accuracy of the DERS in adolescents.

Emotion regulation difficulties in pediatric OCD (Studies III and IV)

Our systematic literature search on ER difficulties in pediatric OCD found that children and adolescents with OCD exhibit more pronounced ER difficulties compared to non-clinical controls (**Table 1**). These difficulties were also partially related to OCD functioning. Treatment studies in this area yielded mixed results, likely due to the variability in treatment paradigms across studies. Notably, significant gaps in the existing literature were identified, including the exclusive reliance on questionnaires and the lack of investigations into whether observed treatment effects were specifically attributable to ERP or to shared therapeutic factors. To address these gaps, we conducted two studies: one examining ER difficulties in pediatric OCD prior to treatment using a multi-informant and multi-method approach, and the other study exploring ER difficulties before and after treatment, specifically assessing whether observed effects were attributable to ERP. The following section will discuss the main findings from these studies in turn.

Pre-treatment emotion regulation difficulties in children and adolescents with OCD (Study III)

As the first study of its kind, we concurrently examined self- and parent-reported ER difficulties, alongside behavioral and psychophysiological indices, in a clinical sample of children and adolescents with OCD. To

establish a normative range of ER, we compared these results to those from sex- and age-matched non-clinical controls.

Self-reported and parent-reported indices of emotion regulation difficulties

As anticipated, children with OCD were less confident in their ability to effectively regulate their emotions, as indicated by both themselves and their parents. Notably, these difficulties were evident across almost all subscales of the DERS. Clinically, this means that children with OCD have difficulties refocusing, concentrating, and completing tasks when upset. Moreover, when distressed, they feel more overwhelmed and out of control, unable to alleviate their emotional discomfort, and believe that it will take a long time to feel better. Interestingly, they also report a sense of uncertainty about their emotions, more often feeling confused about what they are actually experiencing. These self- and parent-reported findings align with previous studies in suggesting that children and adolescent with OCD exhibit decreased abilities to effectively regulate their emotions (McKenzie et al., 2020b; Yazici & Yazici, 2019; Öztürk et al., 2023).

The cognitive model of OCD posits that dysfunctional beliefs regarding the inability to accept or tolerate the negative emotions associated with obsessive intrusions contribute to the development and maintenance of the disorder (Calkins et al., 2013). Non-acceptance of emotions was identified as the ER difficulty most consistently associated with OCS in the systematic review by See et. (2022). In pediatric literature, two studies employing the DERS also found non-acceptance to differ between adolescents with and without OCD, aged 11-18 years (Yazici & Yazici, 2019; Öztürk et al., 2023). However, in our study, self-reported non-acceptance was the only domain on the DERS that did not show a significant difference between adolescents with and without OCD, despite higher scores observed in the OCD. This discrepancy warrants further exploration, particularly regarding potential moderating factors such as OCD symptom heterogeneity, comorbid conditions, and cultural influences, which may impact the relationship between non-acceptance and OCD symptomatology in pediatric populations.

Previous studies using the DERS in pediatric OCD samples have relied on self-reports (Yazici & Yazici, 2019; Öztürk et al., 2023). Here, Yazici and Yazici (2019) found that children with poorer insight reported greater ER difficulties. In our study, we included parent-reports alongside self-reports to provide an additional perspective, potentially validating the self-reported data and providing a more comprehensive understanding of the ER difficulties in pediatric OCD. The inclusion of parent-reports consolidated the findings from the self-reports. Interestingly, parents to children with OCD reported their children to exhibit greater ER difficulties across all domains compared to the children's own self-reports. Notably, findings from the non-clinical group were in the opposite direction, with self-reports indicating greater, albeit subtle, ER difficulties compared to parent-reports. While speculative, these contrasting patterns may equally reflect

genuine differences between the groups as well as potential variations in reporting styles. Specifically, parents of children within the mental health care system may be more attuned to and focused on their child's emotional and behavioral difficulties, whereas parents of children outside the healthcare system may be less likely to emphasize or be aware of such challenges. This hypothesized dynamic may help explain some of the reporting biases, such as social desirability and recall biases, characterized in the Introduction (Althubaiti, 2016).

Behavioral indices of emotion regulation difficulties

The findings from the frustration task indicated that children with OCD exhibited greater difficulties in behaviorally regulating emotions, as assessed by the TEC-M. The TEC-M, based on the strategy model of ER, serves as an observational measure to evaluate behavior and, consequently, overt use of ER strategies. The global EmReg score used in the OCD baseline study is a composite score that includes various ER strategies such as avoidance, reappraisal, seeking support, and emotional reactivity, including both positive and negative emotional expressions. While the EmReg score offers an indication of potential behavioral deviations between children with OCD and other groups of children, it is challenging to disentangle what specific aspect or strategy of ER are most problematic for children with OCD:

As identified in the systematic literature search, no other studies have specifically investigated behavioral ER difficulties in children with OCD. However, insights from other behavioral research on pediatric OCD may provide context for understanding and interpreting our findings. A key focus in these studies has been the quality of observed parent-child interactions, particularly during threat-related problem-solving tasks, where the dyad discusses situations involving hypothetical social, physical, or OCD-related threats (P. Barrett et al., 2002). In relation to our research, relevant findings indicate that children with OCD tend to use less constructive problem-solving strategies, appear less confident and more uncertain in their problem-solving abilities compared to children with other anxiety disorders, externalizing disorders, and non-clinical controls (Barrett et al., 2002; Mathieu et al., 2015). Notably, these studies also suggest that parental behaviors in the OCD groups may differ from those in other groups. Specifically, parents of children with OCD were found to be less likely to reward independence (Barrett et al., 2002) and to exhibit more aversive behaviors (Mathieu et al., 2015), although other have reported no difference in parenting behaviors (Mantz & Abbott, 2020). Given that ER is context-dependent, it is essential to consider the environment in which children regulate their emotions. While our current study does not explicitly examine parental influence, the EmReg score accounts for parental involvement in estimating the child's ER abilities. Additionally, the TEC-M includes parent and dyad scores, providing a promising avenue for future research. Investigating how parental

behaviors influence ER in children with OCD could provide valuable insights into the role of family dynamics in the interaction between ER and OCD.

Collectively, these findings offer preliminary insights into children with OCD exhibiting behavioral ER difficulties compared to non-clinical children. However, further research is needed to identify the distinct regulatory challenges specific to OCD. A clearer understanding of these challenges could help identify more modifiable psychotherapy treatment targets aimed at improving both ER difficulties and symptomatology in children with OCD. Furthermore, by identifying specific behavioral ER difficulties early in children at risk for developing OCD, interventions could be tailored to address these issues before they intensify.

Psychophysiological indices of emotion regulation difficulties

Examining heart rate and HRV patterns across the frustration task supported the notion that the task was indeed taxing, albeit with similar effects across both groups. While HRV has been theoretically proposed as a potential biomarker of autonomic dysfunction related to mental health disorders (Ramesh et al., 2023), only two studies have previously examined the autonomic functioning in children and adolescents with OCD. Findings from these studies are largely consistent with ours, reporting no significant HRV differences between children with and without OCD at rest (Rozenman et al., 2022; Zahn et al., 1996) nor in response to a mildly stressful auditory task (Zahn et al., 1996). Notably, Rozenman et al. (2022) found that compared to non-clinical children, children with OCD exhibited a higher heart rate at rest, speculating that it could serve as a potential marker of disorder severity, pending further replication in larger-scale studies. However, the results from our own larger-scale study showed similar mean heart rate in both the clinical and non-clinical group, comparable to the clinical group in Rozenman's study. Before embarking on further replication, we suggest that future studies consider important avenues for refining research approaches, including accounting for the impact of comorbidities, adjusting frequency bands to accommodate faster spontaneous breathing in children, using age-binned groups to detect subtler variations or incorporating nonlinear analyses to capture more complex HRV patterns (Quintana et al., 2016).

Emotion regulation as outcome, moderator, and mediator in pediatric OCD treatment (Study IV)

Previous research on treatment outcomes for pediatric OCD in relation to ER difficulties has primarily focused on the effects of CBT, with or without psychopharmacological augmentation (Knowles & Tolin, 2024; McGuire et al., 2013; McKenzie et al., 2020a; McNamara et al., 2014). Notably, none of the four

treatment studies included a treatment control group, thereby limiting the ability to assess the specificity of the findings to CBT. Furthermore, only McGuire et al. (2013) incorporated family involvement (in three out of 14 sessions), and this was limited to half of the sample ($n = 78$). To our knowledge, our study is the first to investigate whether the observed effects in relation to ER difficulties are linked to shared treatment components or are specifically linked to ERP, the proposed active ingredient in pediatric OCD treatment. Given the established importance of family involvement in pediatric OCD treatment (National Institute for Health and Care Excellence (NICE), 2005; Pagsberg et al., 2022; Piacentini et al., 2011; Thomsen et al., 2013), as well as its crucial role in the development of ER abilities in children, we adopted a family-based approach in our study.

Treatment outcome

Our findings demonstrated that ER difficulties decreased in adolescents receiving FCBT, but not in those receiving FPRT. The result for FCBT is consistent with McGuire et al. (2013), who also reported reductions in ER difficulties following CBT. However, our study is the first to specifically attribute these improvements to ERP, rather than to common treatment elements shared across interventions, such as psychoeducation and goal-setting, as suggested by Helland et al. (2022). This distinction is clinically significant, as it highlights that while both FCBT and FPRT may be partially effective in reducing OCD symptoms (Piacentini et al., 2011), adolescents with pre-treatment ER difficulties may overall benefit more from the ERP approach used in FCBT.

Using a study-specific benchmark on the DERS to classify normative versus abnormal ER difficulties, we found that 36.4% of adolescents with OCD reported abnormal ER difficulties prior to treatment, with the proportion decreasing to 21.8% following treatment. While no statistically significant differences were observed between treatment groups in the proportion of adolescents reporting scores within the normative range following treatment, a numerical difference was noted. Specifically, 82.8% of adolescents in the FCBT group reported scores indicative of normative ER at end of treatment, compared to 73.1% in the FPRT group. This pattern persisted among treatment completers, with 84% of adolescents in the FCBT group compared to 77.3% in the FPRT group reporting scores indicative of normative ER.

Other studies examining related ER constructs categorically have found that 20% of children with OCD were emotionally dysregulated before treatment, as indicated by CBCL-DP (McGuire et al., 2013), and 38.5% endorsed the presence of temper outbursts pre-treatment (Krebs et al., 2013). Both studies reported improvements in these ER-related constructs following CBT treatment.

While ER exists along a continuum, categorizing it may provide insights into treatment outcomes and guide clinical decision-making, particularly in identifying which children may require more intensive intervention.

However, as previously discussed, such categorizations have inherent limitations, such as oversimplification, arbitrary cutoffs, lack of flexibility in understanding ER across different settings and developmental stages, and reduced predictive power. These limitations may prevent us from capturing more subtle variations and associations. Therefore, while our findings provide valuable insights, they should be interpreted within the context of these methodological constraints.

Treatment moderator

ER difficulties were not found to moderate either treatment response or treatment progress. These findings differ from those of McNamara et al. (2014) who reported that greater ER difficulties moderated treatment outcomes, resulting in a slower and less substantial reduction in OCD symptoms during CBT. Several factors may explain these discrepancies. First, while we employed family-based CBT, McNamara et al. (2014) used an individual CBT approach, with or without pharmacological augmentation. The active involvement of parents in our approach likely provided additional support, helping children with pre-treatment ER difficulties engage more effectively in therapy. This parental involvement may have buffered the negative effects of ER difficulties, enabling children to respond more positively to treatment. In contrast, the individual approach in McNamara et al.'s study did not offer the same level of parental support, potentially limiting its ability to mitigate the impact of pre-treatment ER difficulties on treatment outcomes. Second, the samples in the two studies differed on comorbidity, with 28.6% of adolescents in the McNamara et al.'s sample having comorbid depression, compared to only 1.3% in ours. Previous research indicates that depressive symptoms are linked to ER difficulties in pediatric OCD (Krebs et al., 2013; McGuire et al., 2013). Therefore, the higher prevalence of depression in McNamara et al.'s sample may have contributed to more severe ER difficulties, potentially influencing treatment outcomes. In contrast, the lower comorbidity of depression in our sample may have resulted in a different relationship between ER difficulties, OCD symptoms, and treatment outcome. Finally, the conceptualization of ER differed between studies; McNamara et al. (2014) focused primarily on emotional control operationalized as behavioral dysregulation, whereas our study emphasized general abilities, including emotional acceptance and clarity (Gratz & Roemer, 2004).

In our study, treatment response was defined as OCD symptom severity measured on a continuous scale (the CY-BOCS) at end-of-treatment. However, an alternative definition categorizes treatment responders as those showing at least a 35% reduction in OCD symptom severity following treatment (Skarphedinsson et al., 2017). In line with this approach, McKenzie et al. (2020a) examined whether children with OCD reporting more ER difficulties at baseline showed poorer treatment response compared to those with less ER difficulties. Their findings indicated that, at end of treatment, a higher proportion of treatment responders were observed in the group with less pre-treatment ER difficulties, and this difference persisted at three-

months follow-up. Comparing the findings from our approach to those of McKenzie et al. highlights the importance of considering how treatment response is defined when drawing conclusions across studies and the need for caution when interpreting results, as different definitions of treatment response can lead to varying interpretations of the data.

Treatment mediator

Our findings did not suggest changes in ER during the course of therapy as a mediator of OCD treatment response. This finding was somewhat surprising in light of well-established theoretical models of OCD treatment, such as the emotional processing theory (Foa & McLean, 2016) and inhibitory learning model (Craske et al., 2014). Both models emphasize the importance of ER-related constructs in symptom reduction, suggesting that reducing emotional reactivity through gradual exposure to feared situations, as well as improvements in the ability to tolerate the induced emotional distress without resorting to maladaptive behaviors like compulsions, contribute to symptom reduction. Although our findings do not support this hypothesis, it is possible that the measurement of ER or the timing of its assessment may not have captured the full extent of its role in treatment response. Furthermore, we may not have had sufficient statistical power to detect more subtle effects, which could also explain the lack of observed mediation in our study.

Challenges in comparing findings: Conceptual and methodological differences

Relating one's research findings to the work of others is a fundamental aspect of the scientific process, as it facilitates the interpretation, validation, and integration of new results into the broader body of knowledge. Comparative analyses not only help contextualize findings but also ensure that they contribute meaningfully to existing theories and frameworks. However, these efforts are not without challenges, particularly when conceptual and methodological differences between studies complicate direct comparisons and synthesis. In the following section I will highlight some of the key differences between our studies of ER difficulties in pediatric OCD and the other studies discussed.

Conceptualization and choice of measures

As discussed in the Introduction, there is no universally agreed-upon definition of ER, nor is there consensus on the best approach to assessing aberrant ER. In this thesis, I chose to integrate two key models of ER to provide a comprehensive understanding of ER difficulties, with a particular focus on children and

adolescents' perceived ability to regulate emotions and the strategies they may use in doing so. I framed the scope of this investigation as ER difficulties and, in doing so, deliberately included other terms used in the literature, such as emotional control and emotion dysregulation. While these concepts may explain overlapping aspects of emotional functioning, it is important to acknowledge their distinctions.

Two studies included in the literature overview focused on emotional control, as operationalized by the BRIEF-EC (McKenzie et al., 2020a; McNamara et al., 2014), while one study examined dysregulation as operationalized by the CBCL-DP (McGuire et al., 2013). Rather than measuring ER per se, the primary aim of these measures are to detect problems in emotional and behavioral functioning, exemplified by items such as item 6 from BRIEF: *"Has explosive, angry outbursts"* (Gioia & Isquith, 2011) and item 28 from CBCL-DP: *"Is shy or inhibited"* (Achenbach, 1999). This approach diverges from the broader ER difficulties assessed using the DERS, exemplified by item 5: *"I have difficulty making sense out of my feelings"* and item 15: *"When I'm upset, I believe I'll remain that way for a long time"* (Gratz & Roemer, 2004). A potential avenue for future studies could be to investigate how these differing conceptualizations of aberrant ER convergence in pediatric OCD and explore their clinical implications.

Design of treatment studies

As previously emphasized, the treatment studies included in the literature overview primarily employed CBT; however, several key differences should be considered when interpreting and comparing results. These studies varied in treatment formats (e.g., face-to-face vs. online), psychotherapy dosages (e.g., daily vs. weekly), and treatment duration (ranging from 3 to 17 sessions). Moreover, some studies incorporated pharmacological augmentation, with different types of medication and the number of drug trial arms varying from one to three. Importantly, none of these studies used family-based approaches or reported on therapist fidelity to the treatment protocols. In contrast, our study involved a 16-week, face-to-face family-based psychotherapy intervention, incorporating either ERP or relaxation-based techniques, with external fidelity ratings of both treatment arms. Furthermore, while all studies assessed pediatric OCD within comparable age ranges, differences in comorbidities, medication status, and variability in ER measures, may contribute to differences in findings. These factors highlight the importance of recognizing study-specific variations when interpreting results and drawing conclusions.

Finally, while two pediatric OCD studies have employed the DERS to assess pre-treatment difficulties (Yazici & Yazici, 2019; Öztürk et al., 2023), no pediatric studies have incorporated the DERS in a treatment design, making it difficult to directly compare our findings to others. However, preliminary findings from adult studies (N = 131) suggest that two subscales of the DERS, emotional clarity and awareness, may predict OCD symptom severity following CBT (Bredemeier et al., 2022). A related study from the same

research group found that the DERS-T score mediated reductions in anxiety sensitivity by end of treatment in a transdiagnostic adult sample ($N = 274$), primarily diagnosed with OCD (Asnaani et al., 2020). Among the individual DERS subscales, impulse control emerged as the strongest mediator. While analyses in these studies were not pre-registered, and the latter study did not examine OCD specifically, the findings suggest that future pediatric treatment studies using the DERS may benefit from including a larger sample size and examining the individual subscales from the DERS rather than the total score. This approach could provide a more nuanced understanding of how specific aspects of ER influence treatment progress and response, potentially revealing effects that were masked within the overall score.

Chapter 5: Strengths and limitations

The work presented in this thesis offers several strengths. First, it takes a comprehensive approach to investigating ER difficulties in children and adolescents, using multiple methods and diverse sources of information. Second, while primarily focused on pediatric OCD, the thesis situates ER difficulties within a broader transdiagnostic framework, as demonstrated by the referral study (Ellehauge et al., 2023). Third, the thesis raises important questions about what defines normal and abnormal ER, as illustrated through the DERS study (Thoustrup & Olsen, 2024). These contextualizing and methodologically qualifying studies enhance the interpretation of ER difficulties, providing a clearer understanding of their role in pediatric OCD and strengthening the overall contribution of the research.

The clinical OCD studies also have several strengths. First, the inclusion of a large, well-characterized group of children and adolescents with OCD, alongside a matched non-clinical group, which was systematically assessed using the K-SADS-PL for prior and current psychiatric morbidity and recruited from the Danish registers. Second, the OCD sample was medication-naïve and presented with a range of comorbidities. While the presence of comorbidities could be considered a limitation due to their potential confounding of findings specific to OCD, comorbidities are highly prevalent in pediatric OCD (Sharma et al., 2021). As such, the inclusion of comorbid conditions enhances the generalizability of the sample, providing a more accurate representation of the clinical heterogeneity seen in pediatric OCD populations. Third, the multi-method, multi-informant approach used to assess ER difficulties in the baseline study represents a novel contribution to pediatric OCD research, combining four methods for the first time. This integration of diverse perspectives and data sources provides a comprehensive and nuanced evaluation. Fourth, the publication of a detailed statistical analysis plan for the treatment study represents a significant strength, ensuring transparency and rigor in the research process. Fifth, the treatment study's integrated examination of ER difficulties as treatment outcomes, moderators, and mediators is unprecedented in pediatric OCD research. Finally, the rigorous design in the TECTO trial facilitated the opportunity to distinguish whether ER effects were related to shared therapeutic elements or specifically to the ERP component, considered the active ingredient in OCD treatment.

However, several limitations should also be considered when interpreting findings from the OCD studies. First, children in the non-clinical control group had a higher average IQ than those in the OCD group. This difference in IQ could introduce bias, as cognitive abilities can influence ER (Martin & Ochsner, 2016), potentially confounding group comparisons. However, we chose not to control for IQ differences, as the causal relationship between IQ, ER, and OCD is not well-established, and adjusting for IQ could introduce its own confounding biases (Dennis et al., 2009). Second, the broad age range (8-17 years) of the sample

ensured diverse representation of pediatric OCD but also presented challenges in interpreting ER difficulties across such a wide developmental span. ER evolves rapidly across childhood and adolescence, with developmental trajectories varying between age groups. Our reliance on linear statistical models may have failed to capture these variations. Future research may benefit from incorporating more sophisticated modeling techniques that account for the non-linear development of ER difficulties across this broad age range. Alternatively, dividing the age groups into smaller, more specific bins may provide a clearer understanding of how ER difficulties relate to pediatric OCD across different age groups. Third, while the frustration task in the OCD baseline study enabled behavioral observation in a dyadic context, it may not have elicited sufficient emotional intensity to trigger significant ER difficulties in the children. This is supported by the VAS scores, which remained in the low to moderate range. Future research could address this limitation by incorporating tasks designed to provoke stronger emotional responses. Alternatively, idiosyncratic tasks tailored to address specific contexts or emotions – beyond frustration - which the child finds particularly difficult to regulate could offer a more personalized and effective approach to capturing ER difficulties in pediatric populations. Finally, while the overall sample was comprehensive, the reduced sub-sample sizes, particularly in the OCD treatment study, limited our statistical power, potentially affecting the reliability of the findings. Consequently, small or moderate effects may have been overlooked, increasing the risk of failing to detect significant relationships or differences. Future studies with larger sample sizes could enhance statistical power and yield more robust conclusions.

Chapter 6: Conclusion

This thesis was driven by a strong interest in understanding ER as a central factor in youth mental health, with a particular focus on ER difficulties in pediatric OCD. To further this understanding, we conducted four studies, each addressing important questions and gaps in the existing literature.

In Study I (the referral study), we identified a high prevalence of ER difficulties among 999 children and adolescents referred to mental health services, with over 60% reporting ER difficulties as a main concern. Younger age (3-8 years) was associated with referrals describing more externalizing behaviors, probably reflecting aberrant ER. This supports the hypothesis that ER difficulties in youth mental disorders may follow a trajectory similar to typical ER development with age-related changes from externalizing to internalizing manifestations. Additionally, this finding emphasizes the importance of investigating how family function may impact early detection and referral patterns. Notably, ER difficulties were the primary concern in twice as many rejected as accepted referrals, suggesting that children with ER difficulties may experience delays in receiving appropriate support, potentially exacerbating their mental health issues.

Study II (the DERS study) aimed to establish a benchmark for normative ER as measured by the DERS. However, based on data from the existing literature, including more than 7,000 adolescents, we found that the cut-off score distinguishing normal from abnormal ER was substantially higher than those reported in most clinical studies. This highlights the challenge of dichotomizing ER difficulties and emphasizes the need for age- and sex-adjusted norms to improve the clinical utility and accuracy of DERS scores in adolescent populations.

Studies III and IV (the OCD baseline and treatment studies) contributed to the growing body of literature indicating that children and adolescents with OCD experience and exhibit more pronounced ER difficulties compared to their non-clinical peers. A novel aspect of our work was the inclusion of psychophysiological indices, where we found no significant differences in HRV patterns between children and adolescents with OCD and non-clinical controls when analyzed using a linear approach. Future research in this area may benefit from employing non-linear and age-adjusted models. In our investigation of treatment effects on ER difficulties within an RCT design, we found that FCBT was associated with significant benefits compared to FPRT. This suggests that the ERP component unique to FCBT has a specific effect on ER difficulties, which does not appear to be attributable to shared therapeutic factors. In terms of further treatment implications, child-reported ER difficulties did not moderate or mediate treatment outcomes in our study, however, these null findings should be investigated in future studies with larger samples.

The ongoing youth mental health crisis highlights the urgent need for research into the factors that drive the development and persistence of mental health disorders in young people. ER has emerged as a key factor contributing to a wide range of these disorders, yet significant gaps remain in understanding its role, particularly in pediatric populations. This thesis has addressed some of these gaps, offering new insights into ER difficulties in pediatric OCD and exploring the dynamic nature of ER and its relevance within the broader landscape of youth mental health, as well as the impact of specific therapeutic interventions.

While this research makes relevant contributions, much remains to be explored. Future studies should adopt more nuanced approaches to capture the individual variability of ER difficulties, taking into account the complex interactions between behavioral, biological, and developmental factors. Additionally, further investigation into the role of family dynamics in influencing ER difficulties is essential for gaining a deeper understanding of their development and impact.

Ongoing research into ER has the potential to advance our understanding of youth mental health and inform more effective, individualized interventions. Ultimately, these efforts could significantly improve clinical outcomes and long-term well-being for young people facing mental health challenges.

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Studies



Study I: The referral study

Frequency and types of emotional dysregulation in referrals to child and adolescent mental health services

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Frequency and types of emotional dysregulation in referrals to child and adolescent mental health services

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Abstract

Introduction: Emotional dysregulation (ED) is a transdiagnostic phenomenon that has received increased attention, because of its potential ability to explain the development and maintenance of various psychiatric disorders. The identification of ED may serve as a potential target for both preventive and treatment interventions, however, the frequency of transdiagnostic ED among children and adolescents has not previously been evaluated. Our aim was to evaluate the frequency and types of ED in accepted and rejected referrals to the Child and Adolescent Mental Health Center (CAMHC), Mental Health Services, Copenhagen, Denmark, regardless of psychiatric status and across diagnoses. We aimed to evaluate how often ED would be a leading cause in seeking professional help, and whether children with ED not directly reflecting symptoms of known psychopathology would have higher rejection rates than children with more distinct symptoms of psychopathology. Finally, we assessed associations between sex and age with various types of ED.

Methods: We examined ED in a retrospective chart review of referrals of children and adolescents aged 3–17 years to the CAMHC between August 1st, 2020, and August 1st, 2021. We ranked problems described in the referral as primary, secondary, and tertiary depending on severity. Further, we examined group differences in the frequency of ED in accepted versus rejected referrals, as well as group differences in types of ED in age and sex distributions, and diagnoses occurring with specific types of ED.

Results: ED was present in 62.3% of the 999 referrals and was assessed as the primary issue in twice as many rejected referrals (11.4%) compared to accepted referrals (5.7%). Boys were significantly more often described with externalizing and internalizing behavior (55.5% vs. 31.6%; 35.1% vs. 26.5%) as well as incongruent affect (10.0% vs. 4.7%), whereas girls were more often described with depressed mood (47.5% vs. 38.0%) and self-harm (23.8% vs. 9.4%). The frequency of different types of ED varied with age.

Conclusion: The present study is the first to evaluate the frequency of ED in children and adolescents referred to mental health services. The study offers insights into the high frequency of ED and the associations between ED and

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subsequent diagnoses, which may prove to be a method of early identification of risk of psychopathology. Our findings suggest that ED may rightly be considered a transdiagnostic factor, independent of specific psychiatric disorders, and that an ED-centered as opposed to diagnosis-specific approach to assessment, prevention, and treatment could target transversal symptoms of psychopathology in a more holistic manner.

KEYWORDS

child and adolescent psychiatry, emotion regulation, emotional dysregulation, psychopathology, transdiagnostic, retrospective chart review

1 | INTRODUCTION

Emotional dysregulation (ED) is a broad concept encompassing maladaptive regulation of emotions, resulting in inappropriate emotional responses.¹ ED is a transdiagnostic phenomenon^{2–5} that has received increased attention because of its ability to explain the development and maintenance of various psychiatric disorders^{2,3} and it has been named a hallmark of psychopathology.⁶

Emotion regulation, on the other hand, is the ability to modulate the intensity and/or duration of emotional states and responses,⁷ which is important to mental health and well-being, and critical for normal development.^{4,8} Emotion regulation processes span behaviors prior to, during, and following an emotion-eliciting situation with examples of adaptive regulation ranging from seeking out joyful situations to performing breathing exercises to calm oneself.⁹ Conversely, maladaptive emotion regulation strategies have been implicated as risk factors for psychopathology and behavioral problems^{8,10} and may comprise avoiding anxiety provoking situations as well as showing aggression or temper tantrums in response to negative emotions. Children with ED may exhibit more extreme emotions, have difficulty down-regulating emotions, and experience more negative emotions.¹¹ As most psychopathology is characterized by intense or persistent negative emotional experiences, ED may create a predisposing vulnerability to the development and maintenance of psychopathology,^{3,10,12,13} while the psychopathology itself may also create difficulties with ED.

An assessment of the frequency and type of ED is highly relevant for several reasons. First, ED has been shown to span diverse psychiatric disorders, making it a target for transdiagnostic research, and second, both ED and psychopathology are continuously evolving and efforts must thus be made to understand these developmental concepts in unison.² Knowledge about how ED is associated with this broad range of disorders will increase

Significant outcomes

- Emotional dysregulation (ED) was described in 623 out of 999 referrals (62.3%). The frequency of ED in referrals to child and adolescent psychiatry has not previously been evaluated in Denmark or any other country.
- ED was described as the primary issue in twice as many rejected referrals as accepted, possibly indicating an unmet need for managing these types of behaviors in primary and/or secondary mental health services.
- We identified variations in the presence of different types of ED described in children and adolescents and subsequent psychiatric diagnoses, which may prove to be a method of early identification of risk of psychopathology.

Limitations

- We retrospectively reviewed medical records which holds data not collected with research purposes, and comprehensiveness, quality, and data relevant to the study may be lacking.
- The validity of the operationalization and assessment of ED constructs may have been negatively affected by the study design (retrospective chart review), as constructs identified as ED may have been either regulatory deficits, behavioral sequelae of ED, or symptoms of psychopathology related to ED.
- We reviewed referrals accepted to only one department of the CAMHC but assumed that referrals to this department would be representative for the population of referred individuals in the rest of the country.

our understanding of the interplay between ED and psychopathology and may potentially in time prove to be a method of countering early signs of psychopathology. Finally, it is important to investigate how often and in what manner ED is expressed at different ages and between sexes to be able to better recognize and understand this phenomenon. While emotion regulation associations with age and sex have been the topic of previous work, this has primarily been investigated with regard to use of explicit regulation strategies, and have, for example, demonstrated increasing use of adaptive strategies with age.¹⁴ Less is known about age and sex associations with manifestations of ED in everyday life. Despite the relevance of ED, the frequency of transdiagnostic ED in referrals to child and adolescent mental health services has not previously been evaluated.

In the present study, we aimed to evaluate the frequency and type of ED in accepted and rejected referrals to the Child and Adolescent Mental Health Center (CAMHC), Mental Health Services CPH, Denmark over the course of 1 year (2020–2021). We examined referrals with regard to source of referral, age and sex of the child in question, and the most pertinent issues described in the referral. Finally, we investigated diagnoses given after psychiatric evaluation and their association with the described type of ED. We were interested in seeing whether the frequency of ED would be different in rejected referrals compared to accepted ones, and whether there were any associations between age or sex and type of ED. We hypothesized that ED would be a frequent problem among children and adolescents, and that ED not directly associated with symptoms of distinct psychiatric disorders would occur more frequently in rejected referrals, thus potentially indicating an unmet need for treatment. Hopefully, our study will increase the understanding of the magnitude of transdiagnostic ED, as well as provide clues as to which types of ED—and thus potential targets of early intervention—are associated with specific diagnoses.

2 | METHODS

The study is an explorative, retrospective chart review (in which already existing data from patient files is utilized to study the research question¹⁵) of referrals sent to the CAMHC between August 1st, 2020 and August 1st, 2021. The time frame was selected to obtain the newest data available at the starting point and to ensure that all seasons were included.¹⁶ The study was approved by the Center for Regional Development (R-21053053) and the Knowledge Center for Data in the Capital Region (P-2021-643).

2.1 | Participant sample

We included data from individuals referred to the CAMHC, aged 3–17 years (both inclusive) at the time of referral—a total of 7718 referrals, which were received by the *Center for Visitation and Diagnostics* (CVD), the central unit in the Capital Region of Denmark responsible for assessing referrals and directing patients to the relevant clinics. Most referrals were accepted by the CVD for further psychiatric assessment and treatment in CAMHC ($n = 5428$, 70.3%). The remaining referrals were rejected if relevant measures had not been taken in the primary health care sector before seeking psychiatric help, if psychiatric assessment was not deemed necessary from the degree of impairment compared to other referrals, or because of missing information or documentation. Rejected referrals were not provided with an alternative offer of assessment or treatment. We analyzed rejected as well as accepted referrals in three outpatient clinics at the CAMHC.

We used stratified random sampling¹⁷ performed in SPSS to create a subgroup of 999 referrals to ensure representativeness regarding percentage-wise distributions of sex, age, and accepted versus rejected referrals (70.3% and 29.7%, respectively). Thus, our subsample of 999 referrals was representative of the total sample of referrals sent in the selected time frame. Children under the age of 3 years were excluded, as ED is difficult to differentiate in children of very young age (as exemplified by the DC:0–5 Diagnostic Manual diagnosis Disorder of Dysregulated Anger and Aggression, which is recommended to only be made in children over 24 months of age¹⁸) and as only one two-year-old patient was accepted in the period. If any supplementary material (data on cognitive tests, results from questionnaires, etc.) was attached to the referral, or if the referral made a direct reference to information in medical records obtained at a hospital visit, such information was analyzed.

2.2 | Sample size

When conducting retrospective chart reviews, the general rule has been to obtain 10 charts per variable under investigation,^{19–21} while fewer charts per variable have also been considered adequate.²² In the present study, we coded the three most prominent issues in the referral, as well as the presence (y/n) of any ER keywords (72 in total), which in turn comprises 75 variables. Considering each variable as independent on its own, a sample size of 999 charts should adequately ensure results that are likely to be true as well as clinically meaningful.²³

2.3 | Procedures

We a priori developed a manual and a coding scheme to provide clear guidelines for data collection.²³ The manual consisted of a description of the process of data collection, and the coding scheme consisted of a list of ED keywords constructed by the research group, so that each keyword appearing in a referral could be registered.

2.3.1 | Selection of keywords

The keywords were general concepts referring to ED, including behavioral manifestations associated with ED, such as worrying or aggression. Although these keywords could thus represent both stringent emotion regulatory processes, they could also be behavioral sequelae of ED, and even words overlapping with symptoms of specific psychiatric disorders. This was necessary to ensure that we would capture as many difficulties related to ED as would be evident from the limited source of information that is a referral. A preliminary list was created, based on diagnostic manuals,^{18,24,25} scientific papers,^{7,9,26–28} and internet searches, and was evaluated by the group at regular meetings. Keywords were added during consensus-readings of several referrals (data-driven keywords), before the list of keywords was permanently finalized. The final coding scheme comprised 72 keywords, which were divided into eight categories: incongruent affect, depressed mood, anxiety/worry, externalizing behavior, internalizing behavior, self-harm, difficulty regulating mood and emotions, and emotion recognition (Appendix A).

2.3.2 | Assessment of referrals

Four assessors (three psychologists with several years' experience in child and adolescent psychiatry and one medical student writing her master's thesis in child and adolescent psychiatry) clinically assessed all 999 referrals for any occurrence of words related to ED. We collected information regarding age at the time of referral, sex, source of referral, and whether the referral was accepted or rejected. The issues described in the referrals were registered by the assessors as primary and potentially secondary and tertiary problems, depending on the described severity of the given issue(s) with the most substantial issue in the referral being coded as the primary problem. For example, a referral could center around a child not being able to attend school due to severe inattention with further descriptions of associated sadness. In this case, the symptoms of inattention would be coded as

the primary problem with sadness as the secondary. Problems could be related to a diagnosis already made at the time of referral, symptoms of a new diagnosis, or ED (including self-harm described as emotion regulatory behavior). Problems described in referrals could also be related to gender identity, pre- or post-operative assessment, suicidal ideation, or attempt of suicide. For a referral to be identified as describing ED, predefined keywords were required to appear in a context suggesting ED. All keywords appearing in the referrals related to ED were registered in the coding scheme.

For accepted referrals, we additionally registered any psychiatric diagnoses given following the referral in question. These diagnoses were established at clinical conferences, at which the mental health professionals (psychologists, medical doctors, or psychiatric nurses) who assessed the child (not part of the research group) conferred their findings with a specialist doctor or psychologist in child and adolescent psychiatry. Diagnoses were grouped into 17 categories based on the ICD-10 diagnostic classification system (Appendix B).²⁵

2.4 | Statistical data analyses

We performed all statistical analyses using SPSS version 25. We used the chi-square test of homogeneity to examine (a) group differences (accepted versus rejected referrals) in source of referral, frequency of ED as the primary, secondary, or tertiary problem, respectively, and type of ED (b) group differences in ED in age and sex distributions, and (c) diagnoses occurring with specific types of ED. For all between-group analyses, we applied a Holm-Bonferroni correction²⁹ to control for multiple comparisons by reporting adjusted *p* values.

3 | RESULTS

3.1 | Descriptive characteristics

The total sample consisted of 702 accepted and 297 rejected referrals. Children in the accepted group had a mean age of 12.4 years (SD 3.8), with 52.4% females, and the group of children in the rejected sample had a mean age of 12.0 years (SD 3.8) with 47.5% females. There were no statistically significant differences between the two groups regarding age ($t(997) = 1.397$, $p = 0.163$) or sex ($\chi^2(1, 999) = 2.044$, $p < 0.153$; Table 1).

The majority of accepted (33.2%) and rejected (70.4%) referrals were sent from general practitioners, but proportions differed significantly between groups with significantly more rejected referrals stemming from general

TABLE 1 Descriptive characteristics of accepted and rejected referrals

	Accepted (<i>n</i> = 702)	Rejected (<i>n</i> = 297)	Total (<i>N</i> = 999)	<i>p</i>
Age range, years	3–17	3–17	3–17	
Mean age, years (SD)	12.4 (3.8)	12.0 (3.8)	12.3 (3.8)	0.163
Female, <i>n</i> (%)	368 (52.4)	141 (47.5)	509 (51)	0.153
Source of referral, %				
Hospital department ^a	25.1	3.4	18.7	<0.001
General practitioner	33.2	70.4	44.2	<0.001
Pedagogical psychological services	31.1	22.2	28.4	0.005
Psychiatrist (private practitioner)	2.0	3.0	2.3	0.318
Psychiatric emergency unit	8.5	1.0	6.3	<0.001
Primary problem (top 5) (%)	1. Symptoms of autism spectrum disorders (17.4) 2. Symptoms of eating disorders (14.2) 3. Symptoms of inattention/hyperactivity (13.5) 4. Symptoms of anxiety (12.4) 5. Suicidal ideation (7.3)	1. Symptoms of inattention/hyperactivity (15.8) 2. Symptoms of affective disorders (14.5) 3. Emotional dysregulation (11.4) 4. Symptoms of anxiety (10.1) 5. Symptoms of autism spectrum disorders (9.8)	1. Symptoms of autism spectrum disorders (15.1) 2. Symptoms of inattention/hyperactivity (14.2) 3. Symptoms of anxiety (11.7) 4. Symptoms of eating disorders (11.3) 5. Symptoms of affective disorders (8.4)	
Most frequent diagnoses after referral (top 5) (%)	1. Autism spectrum disorders ^b (24.2) 2. Hyperkinetic disorders ^c (17.0) 3. Anxiety disorders ^d (15.5) 4. Adjustment disorders ^e (13.8) 5. Eating disorders ^f (13.8)	N/A	N/A	

^aCovers referrals from other hospital departments as well as patients psychiatrically screened at the Center for Visitations and Diagnostics (CVD).

^bCovers the following ICD-10 F-diagnoses: 84.0, 84.1, 84.10, 84.12, 84.5, 84.8, 84.9.

^cCovers the following ICD-10 F-diagnoses: 90.0, 90.1, 90.8, 90.9, 98.8C.

^dCovers the following ICD-10 F-diagnoses: 40.0, 40.01, 40.1, 41.0, 41.00, 41.1, 41.2, 41.3, 41.8, 42.0, 42.2, 93.8.

^eCovers the following ICD-10 F-diagnoses: 43.1, 43.2, 43.20, 43.21, 43.22, 43.23, 43.25, 43.28, 43.8, 43.9.

^fCovers the following ICD-10 F-diagnoses: 50.0, 50.1, 50.2, 50.3, 50.8, 50.9.

practitioners (χ^2 (1, 999) = 116.95, p < 0.001). Significantly more referrals came from the pedagogical psychological services (a municipal service working closely with the schools) in the accepted sample (31.1%) than in the rejected sample (22.2%; χ^2 (1, 999) = 8.00, p = 0.005). We also found significant differences in the number of accepted and rejected referrals coming from a psychiatric emergency unit (8.5% of accepted vs. 1.0% of rejected; χ^2 (1, 999) = 20.07, p < 0.001) and hospital departments (25.1% of accepted vs. 3.4% of rejected; χ^2 (1, 999) = 64.47, p < 0.001; Table 1).

The most frequent primary problems described in accepted referrals were symptoms of autism spectrum

disorder (ASD), eating disorders, and inattention/hyperactivity (Table 1). For rejected referrals, the most frequent primary problems were symptoms of inattention/hyperactivity, symptoms of affective disorders, and ED. Among children and adolescents whose referral was accepted, the most frequent diagnoses established following the referral were ASD's, hyperkinetic disorders, and anxiety disorders, with 22.1% not receiving a diagnosis following the referral. This included patients who did not meet criteria for a psychiatric diagnosis (11.1%), patients already having a diagnosis being referred for medical treatment (6.7%), and patients who did not show up or were transferred to a different hospital (4.3%).

TABLE 2 Frequency and ranking of emotional dysregulation in accepted and rejected referrals

%	Accepted (<i>n</i> = 702)	Rejected (<i>n</i> = 297)	Total (<i>n</i> = 999)	<i>p</i> (accepted vs. rejected)	Adjusted ^a <i>p</i>
ED present as primary, secondary, or tertiary problem	61.2	65.2	62.3		
ED primary problem	5.7	11.4	7.4	0.001	0.003
ED secondary problem	39.5	37.0	38.7	0.731	1.000
ED tertiary problem	16.0	16.8	16.2	0.675	1.000
ED not primary, secondary, or tertiary problem	8.7	14.1	10.3		
ED not present	30.2	20.5	27.3		

Abbreviation: ED, emotional dysregulation.

^aHolm-Bonferroni-correction.**TABLE 3** Sex differences in distribution of emotion regulation problems

	Male	Female	<i>p</i>	Adjusted ^a <i>p</i>
Incongruent affect, <i>n</i> (%)	49 (10.0)	24 (4.7)	0.002	0.012
Depressed mood, <i>n</i> (%)	186 (38.0)	242 (47.5)	0.002	0.012
Anxiety/worry, <i>n</i> (%)	170 (34.7)	176 (34.6)	0.968	0.968
Externalizing behavior, <i>n</i> (%)	272 (55.5)	161 (31.6)	0.000	<0.001
Internalizing behavior, <i>n</i> (%)	172 (35.1)	135 (26.5)	0.003	0.012
Self-harm, <i>n</i> (%)	46 (9.4)	121 (23.8)	0.000	<0.001
Difficulty regulating mood and emotions, <i>n</i> (%)	251 (51.2)	223 (43.8)	0.019	0.057
Emotion recognition, <i>n</i> (%)	34 (6.9)	25 (4.9)	0.174	0.348

^aHolm-Bonferroni-correction.

3.2 | Emotional dysregulation characteristics

In almost two thirds of all referrals, ED was registered as one of the top three problems. ED was ranked as the primary problem in twice as many rejected referrals (11.4%) as accepted (5.7%; χ^2 (1, 999) = 11.81, p = 0.003). ED appeared almost equally as secondary and tertiary problems in the accepted and rejected referrals with more than one third of all referrals describing ED as the secondary problem (Table 2).

Of the 623 (62.3%) referrals describing ED as the primary, secondary, or tertiary problem, the most frequent types of categories were difficulty regulating mood and emotions (47.4%), externalizing behavior (43.3%), and depressed mood (42.8%). The types of ED described in referrals did not differ significantly between accepted and rejected referrals.

We found a discrepancy in the types of ED most frequently described in referrals of boys and girls (Table 3). Significant sex differences were identified in five out of eight categories of ED. Boys were more frequently described with externalizing behavior (55.5%, χ^2 (1, 998) = 58.45, p < 0.001), internalizing behavior (35.1%,

χ^2 (1, 999) = 116.95, p = 0.012), and incongruent affect (10.0%, χ^2 (1, 999) = 9.43, p = 0.012). Conversely, girls were more often described with depressed mood (38.0%, χ^2 (1, 998) = 9.20, p = 0.012) and self-harm (23.8%, χ^2 (1, 999) = 37.10, p < 0.001).

An exploratory analysis of the frequency of categories of ED revealed differences across age groups (Table 4). Externalizing behavior was most frequently described in younger children (71.4% of 3–5-year-olds and 76.8% of 6–8-year-olds), and the frequency decreased with increasing age to 24.1% of 15–17-year-olds. The same pattern was seen for internalizing behavior, which was found in 47.6% of 3–5-year-olds and decreased to 26.0% in 15–17-year-olds, as well as difficulty regulating mood and emotions, which was described in 64.3% of 3–5-year-olds, decreasing to 39.4% of 15–17-year-olds. Self-harm was most frequently described among adolescents aged 12–17 years (22.8% of 12–14-year-olds and 18.1% of 15–17-year-olds). ED words related to anxiety/worry were described in more than one third of patients in all age groups. Depressed mood was described in one third to half of patients in each age group, with the highest frequency found in 12–14-year-olds (49.8%). Emotion recognition was the rarest ED problem to be described in referrals in almost all age groups.

TABLE 4 Age differences in distribution of emotion regulation problems

	3–5 years (<i>n</i> = 84)	6–8 years (<i>n</i> = 99)	9–11 years (<i>n</i> = 174)	12–14 years (<i>n</i> = 289)	15–17 years (<i>n</i> = 353)
Incongruent affect, <i>n</i> (%)	16 (19.0)	23 (23.2)	13 (7.5)	10 (3.5)	12 (3.4)
Depressed mood, <i>n</i> (%)	35 (41.7)	37 (37.4)	57 (32.8)	144 (49.8)	155 (44.3)
Anxiety/worry, <i>n</i> (%)	29 (34.5)	35 (35.4)	58 (33.5)	105 (36.3)	119 (34.0)
Externalizing behavior, <i>n</i> (%)	60 (71.4)	76 (76.8)	105 (60.7)	107 (37.0)	85 (24.1)
Internalizing behavior, <i>n</i> (%)	40 (47.6)	39 (39.4)	50 (28.7)	86 (29.8)	92 (26.0)
Self-harm, <i>n</i> (%)	7 (8.3)	12 (12.1)	18 (10.3)	66 (22.8)	64 (18.1)
Difficulty regulating mood and emotions, <i>n</i> (%)	54 (64.3)	69 (69.7)	89 (51.1)	123 (42.6)	139 (39.4)
Emotion recognition, <i>n</i> (%)	8 (9.5)	7 (7.1)	7 (4.0)	16 (5.5)	21 (5.9)

3.3 | Psychiatric diagnoses in children and adolescents with emotional dysregulation

For all patients with ED as the primary, secondary, or tertiary problem, we investigated type of ED and subsequent diagnoses (Figure 1). We found that ASD's were the most frequent diagnoses in all categories of ED, except for incongruent affect and self-harm. Other frequent diagnoses were hyperkinetic disorders, stress reactions/adjustment disorders, and anxiety disorders, which appeared in the top five in all categories, as well as affective disorders, which appeared in the top five in six out of eight categories. Two diagnoses only appeared in one category each: Oppositional defiant disorder (ODD) was one of the most frequent diagnoses in children described with incongruent affect, whereas eating disorders were one of the top five diagnoses in children described with externalizing behavior.

ASD's were the most frequent diagnoses in children with both externalizing (32.6%) and internalizing behavior (41.5%). Half the children with problems with emotion recognition were diagnosed with ASD's. Almost 40% of children and adolescents with incongruent affect were diagnosed with a hyperkinetic disorder. It was also a frequent diagnostic category in children with externalizing behavior (26.7%). In contrast, hyperkinetic disorders were least frequent in children with depressed mood (17.2%), anxiety/worry (17.2%), and self-harm (17.0%).

Stress reactions/adjustment disorders and affective disorders were most frequent in children with self-harm (26.4% and 17.8%). Affective disorders were not as frequent in children with incongruent affect or externalizing behavior.

4 | DISCUSSION

Although ED has been implicated in various psychiatric disorders and is known to cause significant impairment, the frequency with which a child is referred to child and adolescent mental health services with ED has not previously been investigated. In the present paper, we demonstrate that descriptions of ED were present in two thirds of all referrals and described as the main concern in twice as many rejected compared to accepted referrals, potentially indicating an unmet need for treatment of these types of difficulties.

In Denmark, the vast majority of referrals to child and adolescent mental health services come from general practitioners or school psychologists (the pedagogical psychological services) requesting specialized and interdisciplinary efforts to help children struggling with symptoms of all types of mental illness. This was also reflected in the present study, in which most referrals (accepted and rejected) stemmed from these two sources. We found that significantly more rejected versus accepted referrals came from general practitioners. The same pattern was found in an observational study of referrals to the CAMHC in the Northern Region of Denmark, with referrals from general practitioners being associated with a three times higher risk of rejection from the visitation unit compared to referrals from educational psychologists.³⁰ One explanation for this could be that general practitioners lack sufficient knowledge about the specific procedures for referral as demonstrated by a systematic review, which identified lack of knowledge, skills, tools, time, and resources to be the most important barriers for general practitioners to recognize and manage youth mental health problems.³¹ Most referrals from psychiatric emergency

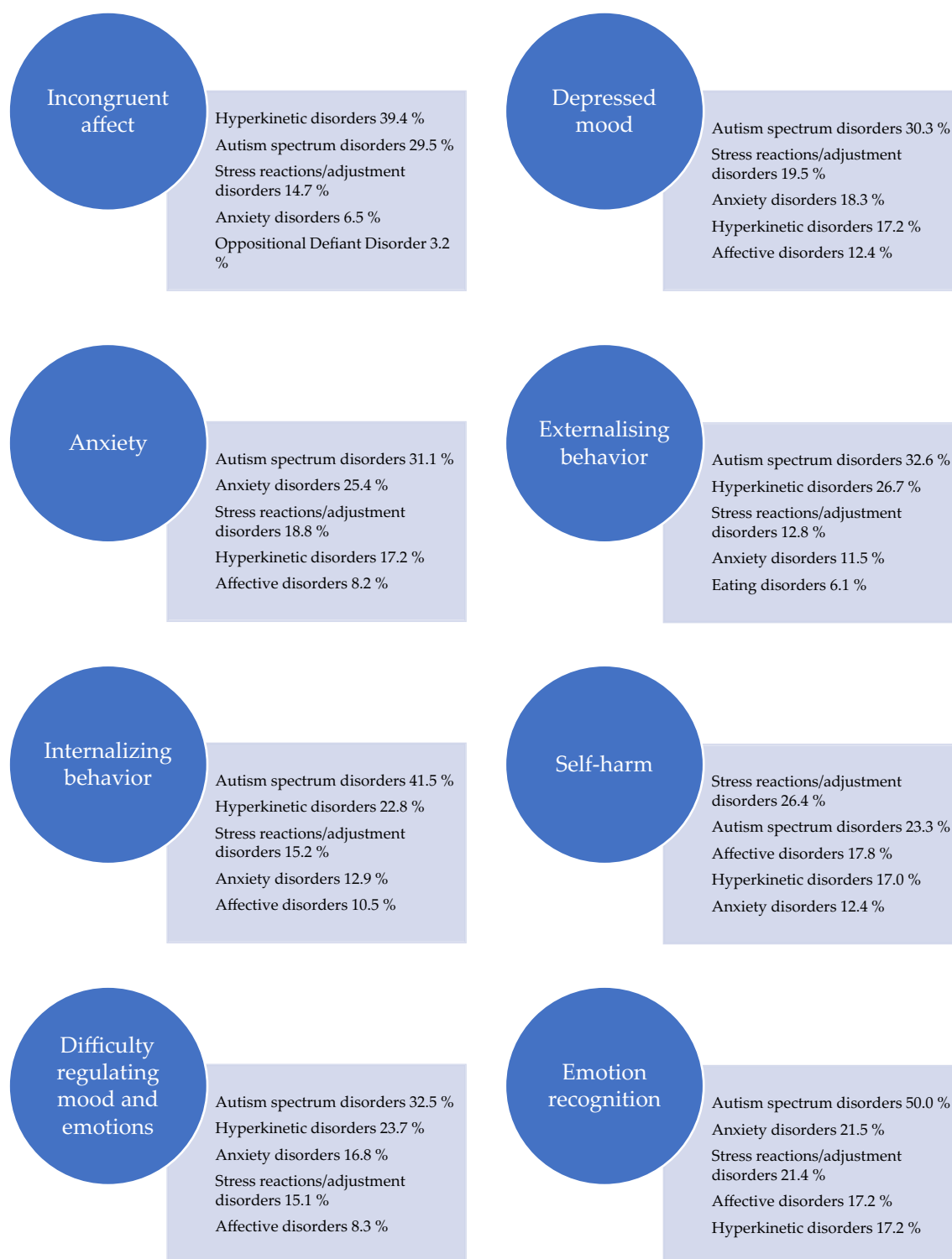


FIGURE 1 Most frequently occurring diagnoses in children with emotion regulation problems. The figure presents the five most frequently occurring diagnoses in children with different types of ER problems (incongruent affect, depressed mood, anxiety/worry, externalizing behavior, internalizing behavior, self-harm, difficulty regulating mood and emotions, emotion recognition), and the frequency of each of these diagnoses. Children were registered with different types of ER problems depending on which ER keywords were used to describe their feelings, behavior etc. in the referral for psychiatric assessment.

units or hospital departments were accepted, indicating knowledge about referral procedures and that patients may suffer from more severe symptoms when turning

to a psychiatric emergency unit or being admitted in a pediatric hospital department, for example due to suicide attempt or pathological underweight.

The higher frequency of ED as the primary concern in rejected referrals, despite the two groups being similar regarding age, sex, and type of ED, could be explained by the assumption that ED not specific to an established diagnosis does not elicit psychiatric assessment. Acceptance of a referral describing ED, on the other hand, appeared to depend on descriptions of symptoms specific to a psychiatric disorder. Symptoms of ASD's, eating disorders, and suicidal ideation were among the most frequent primary problems of accepted referrals, indicating that problems with a need for more acute treatment or with a clear and distinct change in behavior may often lead to a referral being accepted,³⁰ whereas emotional or behavioral problems may be less specific to a particular diagnosis, which could lead to rejection of the referral. Although not conforming with diagnostic criteria, ED may, however, still severely affect well-being and leave parents in need of professional help.

We found no significant differences in the types of ED described when comparing accepted and rejected referrals, indicating that the specific type of ED is not decisive as to whether the referral is accepted or rejected. Combined with the fact that more rejected referrals had ED as the primary problem, the ranking of ED may be the decisive factor in whether the referral was accepted or rejected. As children who primarily struggle with ED are more often rejected from psychiatric assessment, it would be relevant to investigate whether these children receive support in the primary health sector. Furthermore, it would be interesting to examine whether they are referred again in the future with more distinct symptoms of psychopathology.

Boys were more often described with externalizing behavior, which is supported in prior literature.³² Attention-deficit/hyperactivity disorder (ADHD), ASD's, and associated externalizing symptoms are more common in boys than girls and may be an explanatory factor in these findings.³² Internalizing behavior, characterized by anxiety, depression, and self-harm has been found to be more common in girls than boys,^{33,34} supporting our findings of girls more frequently being described with depressed mood and self-harm. Conversely, we found that internalizing behavior characterized by withdrawal and shutting down was more frequent in boys. Although we identified internalizing behavior in many children, the numbers may be even higher due to under-referral, as internalizing behavior tends to be more subtle and go unnoticed by caretakers.³⁵

Several types of ED were more frequent in younger children than adolescents. Nascent mental problems in younger children may be characterized by diffuse symptoms, which may not crystallize as specific diagnoses until later in adolescence, causing this age group to

primarily be described with more general ED terms, which did not yet point to a specific disorder. Self-harm was more common in adolescents than in children in line with existing literature^{33,36–38} and a recent study found that ED in particular contributed to self-harm in adolescents.³⁹ Self-harm is typically used as a way of coping with difficult thoughts or feelings^{33,37} and may be a deliberate strategy of regulating emotions. Risk factors for self-harm include adverse childhood environment and experiences, maladaptive parenting, and childhood maltreatment,³⁸ which may lead to stress reactions or adjustment disorders, possibly explaining that these were the most frequent diagnoses in children with self-harm.

When examining the most frequent diagnoses associated with each type of ED, we saw that ASD's, hyperkinetic disorders, stress reactions/adjustment disorders, and anxiety disorders were present in all ED categories, with affective disorders being present in almost all categories, indicating that a broad spectrum of psychiatric diagnoses were related to ED in general. This is well in line with research on ED as a transdiagnostic factor in psychopathology, linking it broadly to most types of mental disorders.² Almost one in four children received a diagnosis of ASD and almost one in five received a diagnosis of ADHD following an accepted referral, consistent with the most frequent disorders in the CAMCH. This presentation differs somewhat, however, from that in the general population, in which the most frequent diagnosis for boys is ADHD followed by anxiety disorders, and ASD, whereas the most frequent diagnosis for girls is anxiety disorders, followed by ADHD and mood disorders.⁴⁰ One explanation for this could be that symptoms of ASD and ADHD are relatively easy to identify in a referral, which would lead to higher acceptance rates. During the pandemic, with an increased strain on the mental health services, the referral would have to describe distinct symptoms of psychopathology with significant impairment and often comorbidity in order to be accepted, which may explain why many children in this selected sample met criteria for ASD and ADHD. Eating disorders were some of the most frequent diagnoses in children with externalizing behavior such as aggression, irritability, agitation, or temper tantrums, which is consistent with a study that identified externalizing behavior as a predictive factor in developing an eating disorder.⁴¹ Eating disorders have been found to correlate with high negative affectivity, emotional instability, anxiety, depression, guilt, and low self-esteem,⁴¹ showing the relevance of (regulation of) emotions to this diagnostic category. This is important for the prevention and early intervention against eating disorders, as it gives clinicians the opportunity to assess children at risk.

To the best of our knowledge, the frequency of ED in referrals to child and adolescent psychiatry has not been examined previously in Denmark, nor in any other country in the world. The strengths of the present work further include a large sample of both accepted and rejected referrals. Several limitations, however, were also present. We reviewed medical records, which hold data not collected for research purposes, and comprehensiveness, quality, and data relevant to the study may be lacking.⁴² Accordingly, we were not able to systematically assess the reasons for rejecting a referral, which holds important information, as some were rejected due to symptom descriptions and others due to practicalities such as missing attachments. Our study may be subject to investigator bias, as it was not possible to blind investigators, because data abstraction and coding of referrals required knowledge of psychopathology and ED. The list of ED keywords developed by the research group was not validated by other information or studies. As mentioned previously, keywords could refer to basic emotion regulatory processes, as well as behavioral sequelae of regulation deficits, and some keywords carried a direct resemblance to classic symptoms of psychopathology, such as “depressed”, which could very likely also appear in the context of a clinical depression. If a word was clearly related to the description of diagnostic features, the potential diagnosis itself, and not ED, would be coded as the problem, however. As our data consists of words extracted from medical records, it was up to the investigator to assess whether the words were related to ED. The ranking of problems was also determined by clinical assessment by investigators; however, frequent consensus ratings were held to ensure alignment in ranking. We reviewed referrals accepted to one department of the CAMHC but assumed that referrals would be representative for other mental health services. The generalizability of our findings, however, is limited, as we did not study ED in the general population. Finally, the study was conducted during the COVID-19 pandemic, which may have affected the results, as we experienced a 27% increase in referrals,⁴³ and the prevalence of OCD and other anxiety disorders as well as depressive symptoms and ED may have increased.^{44,45} We acknowledge that particularly the lack of data on why referrals were rejected may have created a potential bias in understanding whether referrals describing ED were rejected due to the described behavior or practicalities such as missing information. To conclude, the present study indicates that ED is a frequent phenomenon in children and adolescents referred to mental health services, spanning psychiatric diagnoses and the continuum from mental health to psychopathology. ED is a transdiagnostic factor affecting many children and adolescents referred for psychiatric assessment.

The associations between ED and subsequent diagnosis may prove to be a method of early identification of risk of psychopathology, and our findings suggest that ED may rightly be considered an independent and transdiagnostic type of behavior, which could benefit from an ED centered approach to prevention and treatment to target symptoms of psychopathology more broadly.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The study was approved by the Center for Regional Development (R-21053053) and the Knowledge Center for Data in The Capital Region of Denmark (P-2021-643).

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APPENDIX A: CATEGORIES OF EMOTION REGULATION PROBLEMS AND EMOTION REGULATION KEYWORDS IN DANISH AND ENGLISH

ER category	Original keywords in Danish	Keywords translated to English
Incongruent affect	Euforisk Glad (overdrevet) Hævet stemningsleje Intens Pjattet Uafstemt	Euphoric Happy (exaggerated) Elevated mood Intense Foolish/silly Maladjusted feelings
Depressed mood	Apatisk/passiv Depressiv Følelsesflad Håbløs/træt af livet/modløs Ked af det/nedtrykt Negativ/pessimistisk Sænket stemningsleje Tomhedsfølelse Trist/ulykkelig	Apathetic/passive Depressed Restricted affect/diminished emotional range Hopeless/weary of life/discouraged Sad/in low spirits Negative/pessimistic Lowered mood Feeling empty Miserable/unhappy
Anxiety/worry	Bange/frygtsom Bekymret Hyperventilere Nervøs Panisk Skrøbelig Usikker Utryg Vagtsom/på vagt/urolig/(hyper)vigil Ængstelig	Afraid/fearful Worried Hyperventilate Nervous Panic Fragile Feeling insecure Feeling unsafe Watchful/on guard/uneasy/(hyper)vigilant Anxious
Externalizing behavior	Affekt Aggressiv Agitation Bide Dramatisk Eksplodere Irritabilitet Kaste Konflikt/skænderi/stridighed Kontrol (ude af) Miste besindelsen/nedsmeltnng Ophidset/opfarende/oprevet/oprørt Rasende/gal/hidsig Raserianfald Reagere voldsomt/overreagere Råbe/skrige Skabe sig Slå/slås/slagsmål Sparke/skubbe Temperament Trampe i gulvet Udadreagerende Uregerlig/ustyrlig/vild/voldsom Vred/sur Vredesudbrud	Affect Aggressive Agitation Bite Dramatic Explode Irritability Throw Conflict/quarrel/dispute Control (out of) Lose temper/meltdown Agitated/irascible/upset/distraught Furious/hotheaded Temper tantrum Overreact Shout/scream Act up Hit/fight Kick/push Temper Stamp one's feet Externalizing behavior Unmanageable/uncontrollable/wild/violent Angry/mad Burst of anger

(Continues)

ER category	Original keywords in Danish	Keywords translated to English
	Ødelægge	Destroy/wreck
Internalizing behavior	Flygte Gå ind i sig selv/blive stille/indelukket Holde på sig selv Lukke ned/af Trække sig tilbage/isolere sig/gemme sig Undertrykke følelser/vende følelser indad Skyldfølelse/dårlig samvittighed	Flee Retreat into oneself/quiet/withdrawn Restrain one's emotions Shut down/shut someone or something out Withdraw/isolate/hide Repress one's emotions/turn emotions inward Feeling guilt/have a guilty conscience
Self-harm	Selvskade	Self-harm
Difficulty regulating mood and emotions	Håndtere/tackle/cope (svært ved at) Nærtagede Bære nag Stress (lav tærskel) Trigge (let at) Græde/grådlabil/let til tårer Humør(svingning) Emotionel/følsom Emotion/følelse/(selv)regulering/dysregulering Oppe at køre/ikke falde til ro Frustreret Emotionelt umoden	Handling/tackling/coping (difficulty with) Touchy Hold a grudge Stress (low threshold for) Trigger (easy to) Cry/uncontrollable episodes of crying/prone to tears Mood (swings) Emotional/sensitive Emotion/feeling/(self)regulation/dysregulation Overexcited/unable to calm down Frustrated Emotionally immature
Emotion recognition	Sætte ord på/genkende følelser (svært ved at)	Put one's feelings into words/recognize emotions (difficulty with)

APPENDIX B: DIAGNOSTIC CATEGORIES AND INCLUDED ICD-10 F-DIAGNOSES

Diagnostic category	F-diagnoses included (ICD-10 codes)
Schizophrenia/psychosis	20.09, 20.9, 20.99, 21, 21.9, 28.9, 29.9,
Affective disorders	32.0, 31.8, 32.1, 32.11, 32.2, 32.3, 32.9, 39.9
Anxiety disorders	40.0, 40.01, 40.1, 41.0, 41.00, 41.1, 41.2, 41.3, 41.8, 42.0, 42.2, 93.8
Stress reactions/adjustment disorders	43.1, 43.2, 43.20, 43.21, 43.22, 43.23, 43.25, 43.28, 43.8, 43.9
Eating disorders	50.0, 50.1, 50.2, 50.3, 50.8, 50.9, DE47.0
Sleeping disorders	51.0, 51.8
Personality disorders	60, 60.3, 60.31, 60.4, 60.6
Self-harm	63.8
Mental retardation	70, 70.0, 70.1, 71.1, 73.1
Autism spectrum disorders	84.0, 84.1, 84.10, 84.12, 84.5, 84.8, 84.9,
Developmental disorders	88, 88.0, 88.8, 88.9,
Hyperkinetic disorders	90.0, 90.1, 90.8, 98.8, 98.8C, 90.9
Oppositional defiant disorder	91.3, 91.4
Tic disorders	95.0, 95.1, 95.2, 95.8, 95.9,
Attachment disorders	94.2, 94.8
Drug abuse	12.1, 12.24, 13.1, 19.21
Unspecified	98.0, 98.2, 98.5, 99.9

Study II: The DERS study

Normative reference interval for youths on the Difficulties in Emotion Regulation Scale (DERS)

Christine Lykke Thoustrup and Markus Harboe Olsen

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Normative reference interval for youths on the Difficulties in Emotion Regulation Scale (DERS)

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Abstract

Background: The Difficulties in Emotion Regulation Scale (DERS) is widely used in both clinical and non-clinical research to assess emotional regulation difficulties. To guide interpretation of scores, establishing thresholds for normative DERS scores is informative. However, despite its widespread use, to date no study has provided such threshold for youths. This literature review aimed to fill this gap by examining the 90% reference interval for the DERS in youths aged 11-19 years. **Methods:** We conducted a systematic search on PubMed (MEDLINE) on 12 March 2024, to identify studies reporting DERS-36 total scores (DERS-T) in youths aged 11-19 years from either community-based populations or healthy volunteers. **Results:** A total of 34 studies were included; 20 studies included community-based participants (n = 6,960), while the remaining 14 studies included healthy volunteers (n = 766), resulting in a total of 7,726 participants. The 90% reference interval for DERS-T from all included participants had a threshold of 121.8 normative emotion regulation in youths. **Conclusion and significance:** This threshold is considerably higher than DERS-T scores reported in most clinical studies and a substantial variation in reference intervals across studies is observed. We identify five main methodological factors related to the DERS-36 and discuss their potential impact on the validity, reliability, and generalizability of findings. Given the DERS-T range of 36-180, we conclude that the 90% reference interval derived from our review is not sufficiently robust to guide clinical or scientific interpretations. Our work is not exhaustive, and further research is needed to validate and test the reliability of this reference interval.

Keywords: Emotion regulation; reference interval; the Difficulties in Emotion Regulation Scale; Youths

Introduction

Emotion regulation difficulties is considered a transdiagnostic factor across psychopathologies (1). The Difficulties in Emotion Regulation Scale (DERS) is a widely used self-report measure in both clinical and non-clinical adolescent populations (2). Since its original validation, the DERS-36 has been cited over than 13,000 times, with translation into multiple languages, and adapted into several short versions (e.g. DERS-8 (3), DERS-16 (4), DERS-18 (5), DERS-32 (6)). The DERS-36 is founded on a conceptual model of emotion regulation involving six superior processes: (1) non-acceptance of

negative emotional responses, (2) difficulties engaging in goal-directed behavior when experiencing negative emotions, (3) difficulties controlling impulses when experiencing negative emotions, (4) lack of awareness of emotional responses, (5) limited access to emotion regulation strategies perceived as effective, and (6) lack of clarity of emotional responses. Relative absence of any or all of these abilities indicate difficulties with emotion regulation, according to Gratz and Roemer (2).

Although extensive clinical research has demonstrated an association between higher scores on the DERS-36 and mental health issues in

adolescents (7–9), no normative threshold for emotion regulation has been established for the DERS-36 in this population. The absence of reference values in healthy youth populations limits our ability to interpret DERS-36 scores in clinical studies, regardless of the population investigated. This gap highlights the need for establishing normative reference values for the DERS-36. To address this, we conducted a literature review aimed to estimating the 90% reference interval for the DERS-36 total score (DERS-T) in youths, drawing from all available studies on Pubmed (MEDLINE) that include either community-based populations or healthy volunteers.

Methods

We conducted a systematic search on Pubmed (MEDLINE) on 12 March 2024. The full search strategy is provided in Supplementary material 1 (p. 1). Titles and abstracts of studies retrieved from the search were screened by CT to identify studies potentially meeting the following inclusion criteria: (1) empirical studies in English; (2) inclusion of youths aged 11 to 19 years, either as healthy volunteers in clinical studies or as participants in community-based studies; (3) use of the DERS-36 as the outcome measure; and (4) reporting of either the total score or scores from all six subscales using summed, mean or median scores.

Studies were excluded based on the following criteria: (1) non-English language; (2) inclusion of participants outside the specified age range; (3) use of

short forms of the DERS; (4) reliance on parent-reported outcomes; and (5) insufficient reporting, such as the omission of standard deviations or other essential statistical data. To standardize across studies, mean scores were converted to summed scores, and subscale scores were aggregated to form a total score.

The full text of each study marked as eligible was then reviewed to confirm eligibility. For studies reporting the DERS-36 at multiple time points, only baseline scores were extracted. A flow diagram detailing the study selection process and reasons for exclusion is provided in Supplementary material 1 (p. 3).

The 90% reference interval was calculated by multiplying the standard deviation of the sample by a z-score of 1.645. Given that higher scores on the DERS-36 reflect more emotion regulation difficulties, the upper reference level is interpreted as the threshold for identifying emotional dysregulation. Thus, results falling above the reference interval (the top 5%) are flagged as “abnormal”. Since the DERS-36 does not have a designated lower threshold, all results below the upper reference interval (the remaining 95%) are flagged as normative levels of emotion regulation.

Results

A total of 1,454 articles were screened of which 33 studies met the inclusion criteria. In addition, we included data from the DERS-T for healthy volunteers from a study by the first author, currently

TABLE 1. Study characteristics

	<i>Community-based</i>	<i>Healthy controls</i>
Number of studies – <i>n</i>	20	14
Total number of participants – <i>n</i>	6,960	766
Age – <i>mean (SD)</i> ¹	15.25 (1.7)	14.77 (1.8)
Sex – <i>n (%)</i>		
Female	4221 (60.6)	381 (49.7)
Male	2732 (39.3)	385 (50.3)
Other	7 (0.1)	0 (0)
Main nationality – <i>n</i>	Australia (1)	Denmark (1)
	China (2)	Norway (1)
	Hungary (1)	Turkey (12)
	India (1)	
	Iran (1)	
	Italy (4)	
	Portugal (1)	
	Spain (1)	
	Sweden (1)	
	Turkey (1)	
	UK (2)	
	USA (4)	
DERS-T score – <i>weighted mean (SD)</i>	84.4 (23.4)	76.5 (20.0)

¹Mean age in community-based populations was available for 22 groups. Age range of 13–17 year was reported by Weinberg et al. (2009) and 12–17 years by Kring et al. (2023).

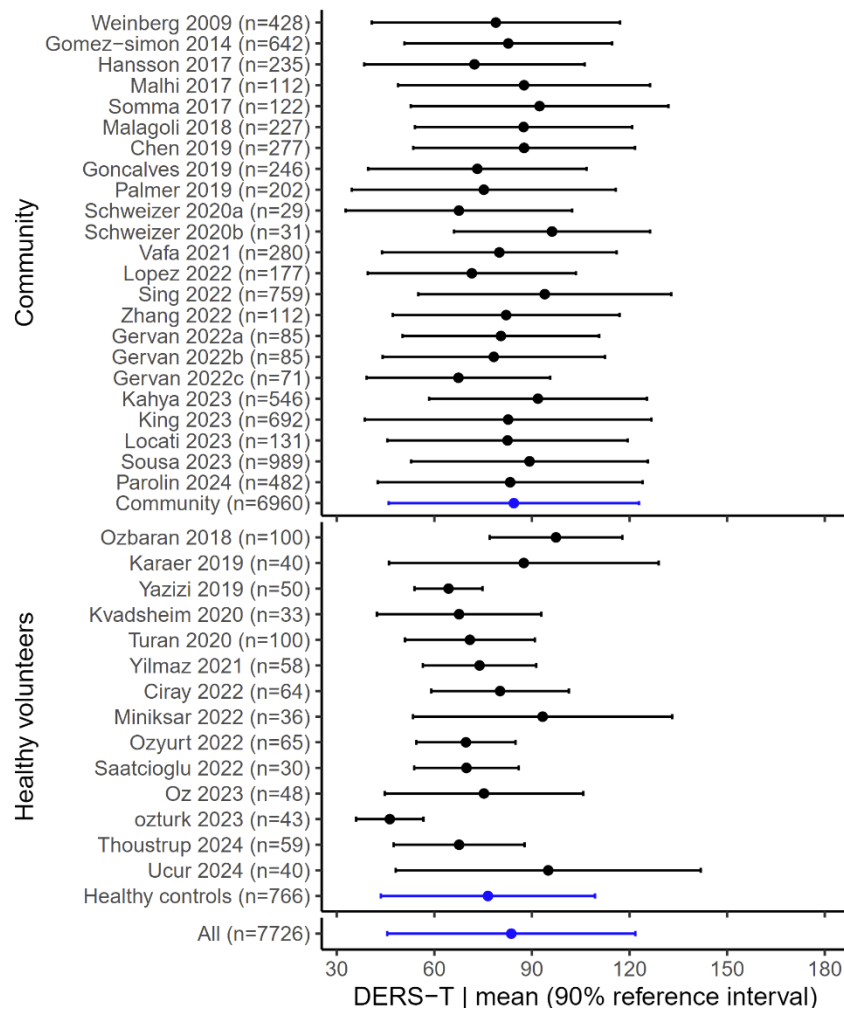


FIGURE 1. Reference interval for DERS-T in youths from community-based populations and healthy volunteers.

The range for the DERS-T is 36 to 180. The reference interval for Community stems from studies using background population data including youths experiencing heightened levels of psychopathology. The reference interval for healthy volunteers stem from studies including youths as symptom-free and psychiatrically healthy. The black reference intervals represent the dispersion of DERS-T from individual studies. The blue reference intervals represent the combined dispersion from three groups respectively: Community-based population (46.0-122.9), healthy volunteers (43.6-109.4), and all (45.5-121.8).

under review for publication. Thus, 34 studies were ultimately included in the calculation of the reference interval for normative emotion regulation. Among these, 20 studies involved community-based populations ($n = 6,960$), while the remaining 14 studies included healthy volunteers ($n = 766$), yielding a total sample size of 7,726 participants. Notably, two of the studies included as a community-based population entailed a total of five different groups (10,11). A summary of the study characteristics is provided in Table 1.

The overall mean DERS-T score was 83.6 ($SD = 23.2$). The reference interval for all included participants ranged from 45.5 up to 121.8, with the upper threshold of 121.8 representing the benchmark for normative emotion regulation, as the DERS-T does not have a designated lower threshold. The reference interval is illustrated in Figure 1. Further details on the reference interval can be found in Supplementary material 2.

Discussion

The present analysis identified a threshold of 121.8 for normative emotion regulation in youths, derived from the DERS-36. This threshold provides a point of reference for clinicians and researchers to evaluate whether an individual's DERS-36 total score aligns with expected normative values or deviates significantly, potentially indicating emotional dysregulation. The established threshold is notably higher than the mean DERS-T scores observed in various diagnostic categories, including suicidality and self-harm, prior to treatment initiation (14–17). However, exceptions exist, particularly in studies examining self-harm where mean DERS-T scores exceed this threshold (18–20).

The substantial variability in reference intervals across studies may reflect a true continuum of normative emotion regulation, suggesting that emotional regulation in youths exists along a spectrum (21). Alternatively, these differences could

be attributed to methodological discrepancies in the use and reporting of the DERS-36, which complicates the generalizability of results across studies and necessitates careful interpretation. Below, we highlight five major themes related to the methodological variation in DERS-36 usage that could impact research findings and clinical interpretation.

1. Inclusion of the emotional awareness subscale

Despite recommendations to remove the emotional awareness subscale due to weak psychometric properties (8,22–24) our study used the DERS-36, incorporating all six subscales. While most research continue to include all six subscales, some adhere to the recommendations by modelling each of the subscales individually (25–27). This discrepancy between psychometric recommendations and current practice may introduce concerns about the validity and reliability of the DERS-36 scores when comparing studies that use different versions of the scale.

2. Reporting formats and standardization

Consistent reporting is essential for the comparability and synthesis of results across studies. While studies in our review followed the guidelines from Gratz and Roemer (2) by providing standard deviations for the summed scale items, other reporting formats, such as reporting mean scores to reflect the original Likert-scale (28,29) or using median scores to reflect non-normal distributions (30), are also prevalent. The variation in reporting formats challenges the interpretation and replication of results. To enhance standardization, future research should consider following the reporting practice proposed by Gratz and Roemer.

3. Missing data and outliers

Missing data and outliers can have a significant impact on results by distorting statistical analyses, thereby leading to inaccurate conclusions (31,32). Of the 34 included studies in our reference interval calculation, only six explicitly addressed missing data, using either methods such as series mean imputation (33–35) or multilevel modeling (36–38). Only one study explicitly accounted for outliers, albeit in generic terms stating to use “a Boxplot method to deal with outliers” (35). The lack of consistent handling of missing data and outliers raises concerns about the robustness and validity of the reported findings.

4. Sociodemographic diversity

Observed variability in the reference interval may be influenced by sociodemographic factors, including age, sex, and nationality. Preliminary work suggests

that the psychometric properties of the DERS-36 are consistent across sociodemographic groups in young adults (39). Future studies should explore whether this consistency holds for adolescents, as differences in sociodemographic characteristics could affect the generalizability of the reference interval for normative emotion regulation in youths.

5. Defining normative emotion regulation

The primary goal of establishing a reference interval was to distinguish between normal and abnormal emotion regulation. Following the work of Schultze-van-Maaren et al. (40) on reference intervals for anxiety measures, we recognize the need for inclusion of participants with varied levels of psychopathology to improve the representativeness of the reference intervals. Though not necessarily symptom-free, the participants should however be psychiatrically healthy, which we cannot ensure in the studies included as community-based populations. Thus, an imperative question on how to define normality remains.

Given the five issues outlined above, along with the significant variability in DERS-T scores across studies, we caution against interpreting the reference interval from the DERS-36 as definitively representing normative emotion regulation in youth. Further validation is necessary to establish the diagnostic accuracy and research validity of this reference interval. Future studies should re-evaluate the threshold through a more comprehensive systematic review, incorporating additional databases and multiple assessors and ideally conduct a meta-analysis to determine whether DERS scores reliably differentiate between normative emotional regulation and clinically significant dysregulation.

Conclusion

In conclusion, the 90% reference interval for the DERS-36 total score in youths, derived from community-based and healthy volunteer-based studies included in this literature review, is not sufficiently reliable for guiding clinical and scientific interpretation. The considerable heterogeneity in the application and reporting of the DERS-36 across studies limits the generalizability of the findings and underscores the need for caution when interpreting results. To validate the proposed reference interval, future research should conduct a meta-analysis, adhering to established methodological guidelines, to ensure greater consistency and reliability in the interpretation of DERS-36 scores.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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Supplementary material 1 - Normative reference interval for youths on the Difficulties in Emotion Regulation Scale (DERS)

1. Method for review on literature using the Difficulties in Emotion Regulation Scale (DERS)

1.1 Search strategy for Pubmed (MEDLINE)

Two independent searches were conducted:

First search - 6th of March 2024

1. "Difficulties in emotion regulation scale"[All Fields]
2. "DERS"[All Fields]
3. 1 OR 2
4. Emotion regulation [All Fields]
5. 3 AND 4
6. Youth* [All fields]
7. Child* [All Fields]
8. Adolescen* [All Fields]
9. young adult [All Fields]
10. 6 OR 7 OR 8 OR 9
11. 5 AND 10

((("Difficulties in emotion regulation scale") OR (DERS)) AND (("Emotion regulation") AND (((Youth*) OR (Child*)) OR (Adolescen*)) OR ("young adult")))) AND (2004/1/1:2024/3/6[pdat])

Inclusion criteria: Articles published 1st of January 2004 to the 6th of March 2024

Result of studies: 345 studies

Second search - 12th of March 2024

1. Difficulties in emotion regulation scale [ti ab]
2. DERS [ti ab]
3. Emotional Regulation [MeSH]

4. 1 OR 2 OR 3

5. adolescent [MeSH Terms]

6. adolescen*[ti ab]

7. youth* [tiab]

8. child* [tiab]

9. 5 OR 6 OR 7 OR 8 OR 9

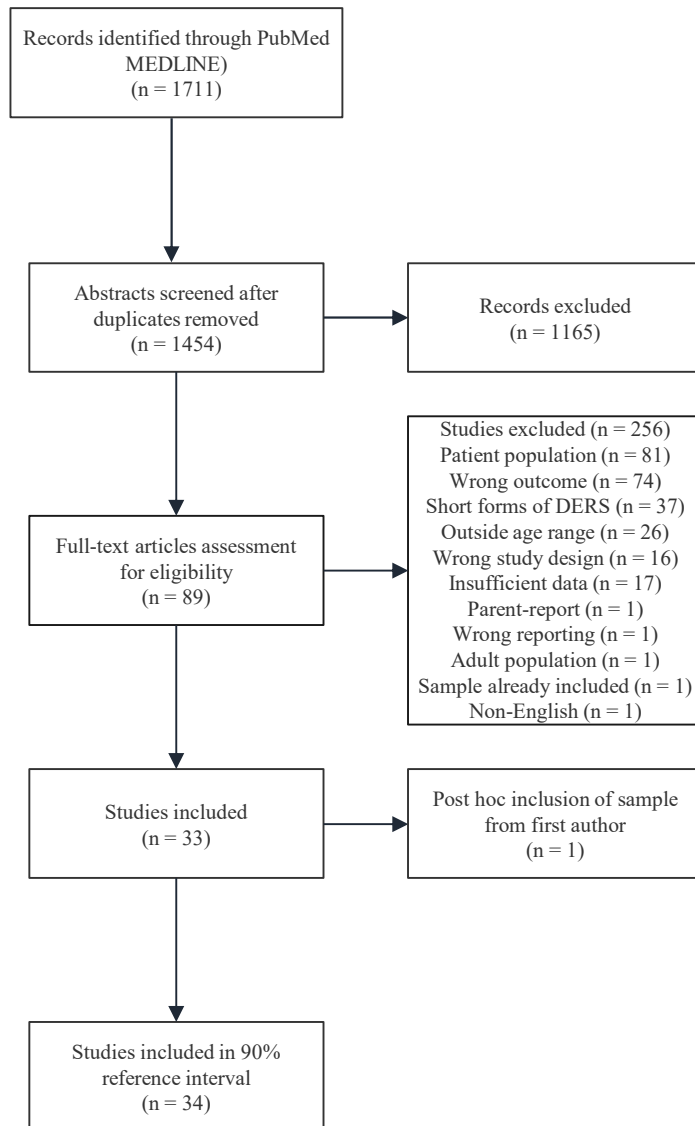
10. 4 AND 9

((("difficulties in emotion regulation scale"[Title/Abstract] OR "DERS"[Title/Abstract] OR "Emotional Regulation"[MeSH Terms]) AND ("Adolescent"[MeSH Terms] OR "adolescen*" [Title/Abstract] OR "youth*" [Title/Abstract] OR "child*" [Title/Abstract])) AND (2004/1/1:2024/3/12[pdat]))

Inclusion criteria: Articles published 1st of January 2004 to the 12th of March 2024

Result of studies: 1366

Flowchart of studies included to estimate the 90% reference interval on the DERS-T



Note. Besides the 33 studies included from the literature search, we also included a study in submission conducted by the first author. Thereby the total studies included for the Literature Norms equals 34.

Supplemental material 2

TECTO exploratory study

DERS Reference interval

CLT; MHO

6/11/24

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Age

Study	group	n	mean	SD
Chen 2019	Community	277	15.38000	1.250000
Ciray 2022	HC	64	14.77000	1.580000
Gervan 2022a	Community	85	14.88000	0.530000
Gervan 2022b	Community	85	15.86000	0.430000
Gervan 2022c	Community	71	15.49000	0.550000
Gomez-simon 2014	Community	642	15.42000	1.690000
Goncalves 2019	Community	246	12.61000	0.640000
Hansson 2017	Community	235	16.18000	1.200000
Kahya 2023	Community	546	16.18000	1.670000
Karaer 2019	HC	40	15.40000	1.100000
King 2023	Community	692		
Kvadsheim 2020	HC	33	14.62000	1.150000
Locati 2023	Community	131	15.37000	1.850000
Lopez 2022	Community	177	12.56000	0.600000
Malagoli 2018	Community	227	16.90000	1.500000
Malhi 2017	Community	112	15.27000	0.540000
Miniksar 2022	HC	36	15.00000	2.070000
Ozbaran 2018	HC	100	14.03000	1.750000
Oz 2023	HC	48	13.98000	2.140000
ozturk 2023	HC	43	14.88000	1.590000
Ozyurt 2022	HC	65	14.60000	1.500000
Palmer 2019	Community	202	14.50000	
Parolin 2024	Community	482	15.60000	2.050000
Saatcioglu 2022	HC	30	15.20000	1.450000
Schweizer 2020a	Community	29	13.51000	0.870000
Schweizer 2020b	Community	31	16.53000	1.110000
Sing 2022	Community	759	16.08000	0.970000
Somma 2017	Community	122	16.69000	1.810000
Sousa 2023	Community	989	15.82000	1.270000
Thoustrup 2024	HC	59	14.41000	2.060000
Turan 2020	HC	100	15.01000	1.490000
Ucur 2024	HC	40	15.92000	
Vafa 2021	Community	280	16.35000	0.820000
Weinberg 2009	Community	428		
Yazizi 2019	HC	50	13.40000	1.600000
Yilmaz 2021	HC	58	15.50000	1.800000
Zhang 2022	Community	112	13.07000	0.730000
All	All	6364	15.45715	1.736625

Reference interval for all

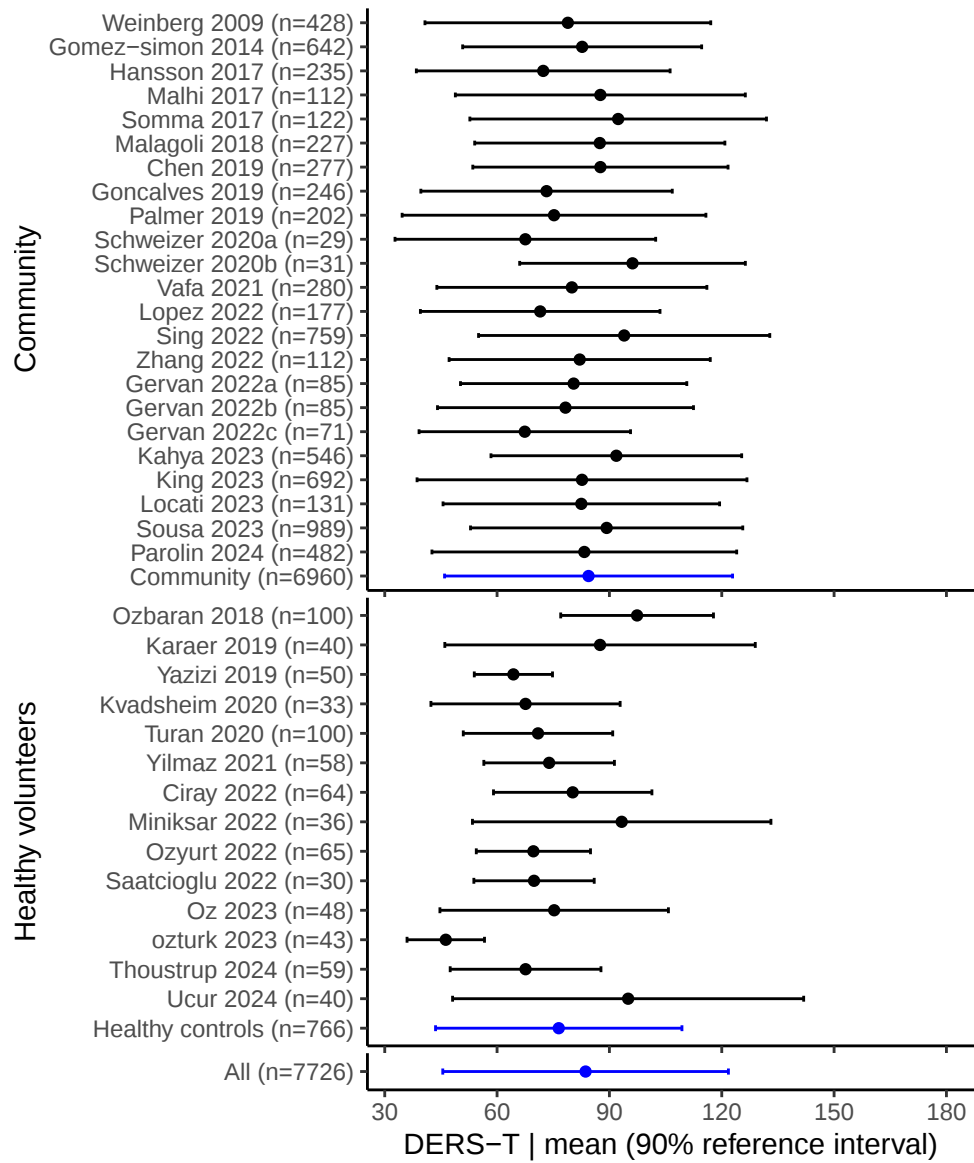


Table 2: Community

Study	n	mean (90%RI)	SD
Weinberg 2009	428	78.9 (40.7-117.1)	23.2
Gomez-simon 2014	642	82.7 (50.8-114.6)	19.4
Hansson 2017	235	72.3 (38.4-106.2)	20.6
Malhi 2017	112	87.6 (48.9-126.3)	23.5
Somma 2017	122	92.3 (52.7-131.9)	24.1
Malagoli 2018	227	87.4 (54.0-120.8)	20.3
Chen 2019	277	87.6 (53.5-121.7)	20.7
Goncalves 2019	246	73.2 (39.6-106.8)	20.4
Palmer 2019	202	75.2 (34.6-115.8)	24.7
Schweizer 2020a	29	67.5 (32.7-102.4)	21.2
Schweizer 2020b	31	96.2 (66.0-126.3)	18.3
Vafa 2021	280	80.0 (43.9-116.0)	21.9
Lopez 2022	177	71.5 (39.5-103.5)	19.4
Sing 2022	759	93.9 (55.1-132.8)	23.6
Zhang 2022	112	82.1 (47.2-116.9)	21.2
Gervan 2022a	85	80.5 (50.2-110.7)	18.4
Gervan 2022b	85	78.3 (44.1-112.5)	20.8
Gervan 2022c	71	67.4 (39.2-95.6)	17.2
Kahya 2023	546	91.8 (58.4-125.3)	20.4
King 2023	692	82.7 (38.6-126.7)	26.8
Locati 2023	131	82.5 (45.6-119.4)	22.4
Sousa 2023	989	89.3 (52.9-125.6)	22.1
Parolin 2024	482	83.3 (42.6-124.0)	24.7
Community	6960	84.4 (46.0-122.9)	23.4

Table 3: Healthy controls

Study	n	mean (90%RI)	SD
Ozbaran 2018	100	97.4 (77.0-117.8)	12.4
Karaer 2019	40	87.5 (46.0-129.0)	25.2
Yazizi 2019	50	64.4 (53.9-74.8)	6.3
Kvadsheim 2020	33	67.6 (42.3-92.9)	15.4
Turan 2020	100	70.9 (51.0-90.9)	12.1
Yilmaz 2021	58	73.9 (56.5-91.3)	10.6
Ciray 2022	64	80.2 (59.0-101.4)	12.9
Miniksar 2022	36	93.3 (53.4-133.1)	24.2
Ozyurt 2022	65	69.7 (54.5-84.9)	9.3
Saatcioglu 2022	30	69.9 (53.8-85.9)	9.8
Oz 2023	48	75.2 (44.7-105.8)	18.6
ozturk 2023	43	46.3 (36.0-56.6)	6.3
Thoustrup 2024	59	67.6 (47.5-87.7)	12.2
Ucur 2024	40	95.0 (48.1-141.9)	28.5
Healthy controls	766	76.5 (43.6-109.4)	20.0

Table 4: All

Study	n	mean (90%RI)	SD
All	7726	83.6 (45.5-121.8)	23.2

Reference interval for girls

Table 5: Community

Study	n	mean (90%RI)	SD
Gomez-simon 2014	642	82.2 (48.2-116.2)	20.7
Hansson 2017	235	79.5 (45.3-113.6)	20.8
Somma 2017	122	93.6 (55.6-131.6)	23.1
Goncalves 2019	246	76.2 (39.7-112.7)	22.2
Schweizer 2020a	29	96.2 (66.0-126.3)	18.3
Vafa 2021	280	80.2 (41.7-118.7)	23.4
Sing 2022	759	94.3 (53.4-135.2)	24.9
Gervan 2022a	85	80.9 (48.9-112.9)	19.5
Gervan 2022b	85	83.6 (47.2-120.0)	22.1
Sousa 2023	989	67.7 (49.8-85.7)	10.9
Community	3472	80.5 (43.8-117.2)	22.3

Table 6: Healthy controls

Study	n	mean (90%RI)	SD
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Table 7: All

Study	n	mean (90%RI)	SD
All	3472	80.5 (43.8-117.2)	22.3

Reference interval for boys

Table 8: Community

Study	n	mean (90%RI)	SD
Gomez-simon 2014	642	82.1 (52.9-111.3)	17.8
Hansson 2017	235	65.2 (32.9-97.4)	19.6
Somma 2017	122	84.9 (50.6-119.2)	20.9
Goncalves 2019	246	70.2 (39.7-100.8)	18.6
Vafa 2021	280	76.6 (39.4-113.8)	22.6
Sing 2022	759	84.2 (58.8-109.6)	15.4
Gervan 2022a	85	80.0 (56.0-104.0)	14.6
Gervan 2022b	85	73.0 (44.2-101.7)	17.5
Gervan 2022c	71	67.4 (39.2-95.6)	17.2
Sousa 2023	989	67.4 (44.3-90.6)	14.1
Community	3514	75.6 (45.0-106.1)	18.6

Table 9: Healthy controls

Study	n	mean (90%RI)	SD
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Table 10: All

Study	n	mean (90%RI)	SD
All	3514	75.6 (45.0-106.1)	18.6

Supplemental table 1 - Included studies

Study	Sample type	Country	n
Malhi 2017	Community	Australia	112
Chen 2019	Community	China	277
Zhang 2022	Community	China	112
Thoustrup 2024	HC	Denmark	59
Gervan 2022a	Community	Hungary	85
Gervan 2022b	Community	Hungary	85
Gervan 2022c	Community	Hungary	71
Sing 2022	Community	India	759
Vafa 2021	Community	Iran	280
Somma 2017	Community	Italian	122
Locati 2023	Community	Italy	131
Malagoli 2018	Community	Italy	227
Parolin 2024	Community	Italy	482
Kvadsheim 2020	HC	Norway	33
Sousa 2023	Community	Portugal	989
Gomez-simon 2014	Community	Spain	642
Hansson 2017	Community	Sweden	235
Kahya 2023	Community	Turkey	546
Ciray 2022	HC	Turkey	64
Karaer 2019	HC	Turkey	40
Oz 2023	HC	Turkey	48
Ozbaran 2018	HC	Turkey	100
ozturk 2023	HC	Turkey	43
Ozyurt 2022	HC	Turkey	65
Saatcioglu 2022	HC	Turkey	30
Turan 2020	HC	Turkey	100
Ucur 2024	HC	Turkey	40
Yazizi 2019	HC	Turkey	50
Yilmaz 2021	HC	Turkey	58
Miniksar 2022	HC	Turkish	36
Palmer 2019	Community	UK	202
Schweizer 2020a	Community	UK	29
Schweizer 2020b	Community	UK	31
Goncalves 2019	Community	USA	246
King 2023	Community	USA	692
Lopez 2022	Community	USA	177
Weinberg 2009	Community	USA	428

Supplemental material

All

Study	group	n	mean (90%RI)	SD
Weinberg 2009	Community	428	78.9 (40.7-117.1)	23.20000
Gomez-simon 2014	Community	642	82.7 (50.8-114.6)	19.40000
Hansson 2017	Community	235	72.3 (38.4-106.2)	20.60000
Malhi 2017	Community	112	87.6 (48.9-126.3)	23.54000
Somma 2017	Community	122	92.3 (52.7-131.9)	24.08000
Malagoli 2018	Community	227	87.4 (54.0-120.8)	20.31000
Ozbaran 2018	HC	100	97.4 (77.0-117.8)	12.40000
Chen 2019	Community	277	87.6 (53.5-121.7)	20.72000
Goncalves 2019	Community	246	73.2 (39.6-106.8)	20.41000
Karaer 2019	HC	40	87.5 (46.0-129.0)	25.20000
Palmer 2019	Community	202	75.2 (34.6-115.8)	24.66000
Yazizi 2019	HC	50	64.4 (53.9-74.8)	6.35000
Kvadsheim 2020	HC	33	67.6 (42.3-92.9)	15.36000
Turan 2020	HC	100	70.9 (51.0-90.9)	12.13000
Schweizer 2020a	Community	29	67.5 (32.7-102.4)	21.16000
Schweizer 2020b	Community	31	96.2 (66.0-126.3)	18.32000
Vafa 2021	Community	280	80.0 (43.9-116.0)	21.92000
Yilmaz 2021	HC	58	73.9 (56.5-91.3)	10.60000
Ciray 2022	HC	64	80.2 (59.0-101.4)	12.86000
Lopez 2022	Community	177	71.5 (39.5-103.5)	19.45000
Miniksar 2022	HC	36	93.3 (53.4-133.1)	24.23000
Ozyurt 2022	HC	65	69.7 (54.5-84.9)	9.27000
Sing 2022	Community	759	93.9 (55.1-132.8)	23.64000
Saatcioglu 2022	HC	30	69.9 (53.8-85.9)	9.77000
Zhang 2022	Community	112	82.1 (47.2-116.9)	21.20000
Gervan 2022a	Community	85	80.5 (50.2-110.7)	18.37000
Gervan 2022b	Community	85	78.3 (44.1-112.5)	20.78000
Gervan 2022c	Community	71	67.4 (39.2-95.6)	17.17000
Kahya 2023	Community	546	91.8 (58.4-125.3)	20.35000
King 2023	Community	692	82.7 (38.6-126.7)	26.78000
Locati 2023	Community	131	82.5 (45.6-119.4)	22.45000
Oz 2023	HC	48	75.2 (44.7-105.8)	18.55000
ozturk 2023	HC	43	46.3 (36.0-56.6)	6.29000
Sousa 2023	Community	989	89.3 (52.9-125.6)	22.10000
Parolin 2024	Community	482	83.3 (42.6-124.0)	24.74000
Thoustrup 2024	HC	59	67.6 (47.5-87.7)	12.24000
Ucur 2024	HC	40	95.0 (48.1-141.9)	28.50000
All	All	7726	83.6 (45.5-121.8)	23.18836
Community	Community	6960	84.4 (46.0-122.9)	23.37875
Healthy controls	HC	766	76.5 (43.6-109.4)	20.00212

Girls

Study	group	n	mean (90%RI)	SD
Weinberg 2009	Community	428		
Gomez-simon 2014	Community	642	82.2 (48.2-116.2)	20.66000
Hansson 2017	Community	235	79.5 (45.3-113.6)	20.76000
Malhi 2017	Community	112		
Somma 2017	Community	122	93.6 (55.6-131.6)	23.12000
Malagoli 2018	Community	227		
Ozbaran 2018	HC	100		
Chen 2019	Community	277		
Goncalves 2019	Community	246	76.2 (39.7-112.7)	22.20000
Karaer 2019	HC	40		
Palmer 2019	Community	202		
Yazizi 2019	HC	50		
Kvadsheim 2020	HC	33		
Turan 2020	HC	100		
Schweizer 2020a	Community	29	96.2 (66.0-126.3)	18.32000
Schweizer 2020b	Community	31		
Vafa 2021	Community	280	80.2 (41.7-118.7)	23.40000
Yilmaz 2021	HC	58		
Ciray 2022	HC	64		
Lopez 2022	Community	177		
Miniksar 2022	HC	36	76.3	
Ozyurt 2022	HC	65		
Sing 2022	Community	759	94.3 (53.4-135.2)	24.86000
Saatcioglu 2022	HC	30		
Zhang 2022	Community	112		
Gervan 2022a	Community	85	80.9 (48.9-112.9)	19.48000
Gervan 2022b	Community	85	83.6 (47.2-120.0)	22.12000
Gervan 2022c	Community	71		
Kahya 2023	Community	546		
King 2023	Community	692		
Locati 2023	Community	131		
Oz 2023	HC	48		
ozturk 2023	HC	43		
Sousa 2023	Community	989	67.7 (49.8-85.7)	10.93000
Parolin 2024	Community	482		
Thoustrup 2024	HC	59		
Ucur 2024	HC	40		
All	All	3472	80.5 (43.8-117.2)	22.30903
Community	Community	3472	80.5 (43.8-117.2)	22.30903
Healthy controls	HC	0	NaN (NaN-NaN)	

Boys

Study	group	n	mean (90%RI)	SD
Weinberg 2009	Community	428		
Gomez-simon 2014	Community	642	82.1 (52.9-111.3)	17.78000
Hansson 2017	Community	235	65.2 (32.9-97.4)	19.60000
Malhi 2017	Community	112		
Somma 2017	Community	122	84.9 (50.6-119.2)	20.87000
Malagoli 2018	Community	227		
Ozbaran 2018	HC	100		
Chen 2019	Community	277		
Goncalves 2019	Community	246	70.2 (39.7-100.8)	18.55000
Karaer 2019	HC	40		
Palmer 2019	Community	202		
Yazizi 2019	HC	50		
Kvadsheim 2020	HC	33		
Turan 2020	HC	100		
Schweizer 2020a	Community	29		
Schweizer 2020b	Community	31		
Vafa 2021	Community	280	76.6 (39.4-113.8)	22.60000
Yilmaz 2021	HC	58		
Ciray 2022	HC	64		
Lopez 2022	Community	177		
Miniksar 2022	HC	36	80.1	
Ozyurt 2022	HC	65		
Sing 2022	Community	759	84.2 (58.8-109.6)	15.42000
Saatcioglu 2022	HC	30		
Zhang 2022	Community	112		
Gervan 2022a	Community	85	80.0 (56.0-104.0)	14.61000
Gervan 2022b	Community	85	73.0 (44.2-101.7)	17.50000
Gervan 2022c	Community	71	67.4 (39.2-95.6)	17.17000
Kahya 2023	Community	546		
King 2023	Community	692		
Locati 2023	Community	131		
Oz 2023	HC	48		
ozturk 2023	HC	43		
Sousa 2023	Community	989	67.4 (44.3-90.6)	14.06000
Parolin 2024	Community	482		
Thoustrup 2024	HC	59		
Ucur 2024	HC	40		
All	All	3514	75.6 (45.0-106.1)	18.59411
Community	Community	3514	75.6 (45.0-106.1)	18.59411
Healthy controls	HC	0	NaN (NaN-NaN)	

Study III: The OCD baseline study

**Emotion regulation difficulties in children and adolescents with obsessive-compulsive disorder:
A multi-informant and multi-method study**

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Title: Emotion regulation difficulties in children and adolescents with obsessive-compulsive disorder: A multi-informant and multi-method study

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Highlights

- We studied emotion regulation difficulties (ED) in pediatric OCD across modalities.
- Children with OCD and their parents reported more child ED.
- Children with OCD displayed more behavioral ED during a frustration task.
- No distinct OCD psychophysiological aberrations in relation to a frustration task.

Abstract

Pediatric obsessive-compulsive disorder (OCD) is associated with emotion regulation (ER) difficulties. Most studies are based on self-reports, while few have examined how these difficulties are expressed across modalities, which may hold important diagnostic and therapeutic information. We applied a multi-informant and multi-method approach to examine ER difficulties in 211 children aged 8 to 17 years: 121 with OCD and 90 non-clinical controls. Child ER difficulties were assessed with The Difficulties in Emotion Regulation Scale (self-report and parent-report) and a Tangram frustration task with investigator-rated behavior, self-rated frustration, and heart rate variability (HRV). Children with OCD differed significantly from non-clinical controls in showing: (i) elevated child ER difficulties on self-report (partial eta squared = .068-.165) and parent-report (partial eta squared = .207-.369); (ii) more investigator-rated ER difficulties during the task (Cohen's $d = -.33$); (iii) increased levels of self-rated frustration before and after the task (partial eta squared = .089); notably, the magnitude of this increase did not differ between children with and without OCD. Finally, (iv) all children, regardless of group, demonstrated significant HRV changes during the frustration task, with no discernible group differences in the magnitude of these changes. Results suggest the OCD-related experience of ER difficulties may not impact autonomic functioning.

Keywords: Emotional regulation; Obsessive Compulsive Disorder; Multidisciplinary Research; Child Health; Adolescent Health; Heart Rate Variability.

1. Introduction

Up to 3% of children and adolescents (from here on denoted children) experience clinical levels of obsessive-compulsive disorder (OCD) (Farrell et al., 2023), a debilitating illness associated with repetitive and intrusive thoughts, urges, images, or impulses (obsessions) and/or repetitive behaviors or mental acts (compulsions) (Stein et al., 2019). A growing body of research has established a link between pediatric obsessive-compulsive symptomatology and the experience and display of negative emotions such as fear, disgust, irritability, anger, and explosive emotional outbursts (Barcaccia et al., 2022; Cervin et al., 2021; Guzick et al., 2021; Krebs et al., 2013; Storch et al., 2012). These findings suggest underlying emotion regulation (ER) difficulties. ER can be conceptualized as an individual's ability to experience and differentiate the full range of emotions, control impulses, behave in a way that facilitates the achievement of a priori goals, and accept own emotions and emotional responses (Gratz & Roemer, 2004). ER difficulties thus refer to an individual's limited ability to effectively engage or manage any or all ER processes. Indeed, children with OCD and their parents report poorer child ER compared to non-clinical controls (Sukhodolsky et al., 2005; Yazici & Yazici, 2019) and to children with anxiety disorders (Bender et al., 2015; Jacob et al., 2012). Furthermore, several studies suggest that poorer ER is associated with more severe pediatric obsessive-compulsive symptomatology (Berman et al., 2018; McGuire et al., 2013; McKenzie et al., 2020a, 2020b). Evidence on ER difficulties in pediatric OCD has predominantly relied on questionnaires, which is suboptimal, as self-reported data are subject to biases such as selective recall, influence of current mood, and social desirability, which may hamper the validity and reliability of findings (Althubaiti, 2016). Therefore, expanding research to include diverse measurement methods has the potential to enhance our understanding of ER difficulties in pediatric OCD and contribute with more robust findings.

One approach to investigating behavioral indices of ER difficulties is to experimentally induce negative emotions, typically through frustration. Results from adult studies suggest that OCD patients experience heightened negative emotional reactions during symptom provocation (van Bennekom et al., 2021) and in response to negative emotional stimuli (Thorsen et al., 2018). There are also indications of difficulties in the recruitment of adaptive ER strategies (Ferreira et al., 2020). However, to our knowledge,

no previous work has examined the extent to which children with OCD show ER difficulties, when facing experimentally induced negative emotions.

Heart rate variability (HRV), a psychophysiological proxy for vagal activity (i.e., parasympathetic nervous system activity), has been promoted as a reliable biomarker of ER (Appelhans & Luecken, 2006; Beauchaine, 2015; Beauchaine & Thayer, 2015). Individuals with higher HRV, i.e. enhanced cardiac vagal control, appear to exhibit and report more flexible and adaptive ER (Graziano & Derefinko, 2013; Visted et al., 2017). Contrary, lower HRV, i.e. lower cardiac vagal control, is associated with less optimal preparation and adaptation to stressful and challenging circumstances (Beauchaine, 2015). Such “autonomic rigidity” has been hypothesized to be at play particularly in internalizing disorders, which in conjunction with core symptoms such as worry and rumination may result in ER difficulties (Paniccia et al., 2017). As such, indexing HRV may be of considerable utility in examining ER difficulties. Studies examining HRV in adult patients with OCD are scarce and have produced inconsistent results (Pittig et al., 2013; Sandhya et al., 2022; Simon et al., 2013; Slaap, 2004; van Bennekom et al., 2021). To date, only two studies have examined HRV in children with OCD showing no significant differences in HRV between children with and without OCD (Rozenman et al., 2022; Zahn et al., 1996). Notably, the studies have several limitations, such as obsolete data analyses methods, questionable representativity of sample compositions, and the inclusion of participants receiving psychotropic medication. Thus, the association between HRV and pediatric OCD remains inconclusive.

The aim of the current study was to examine how different modalities of ER difficulties are expressed in pediatric OCD. To account for the complexity of ER, we adopted a theoretical framework integrating two influential models: James Gross’ process model of ER (1998), which emphasizes ER strategies, and the multi-dimensional model by Gratz and Roemer (2004), which focuses on perceived ER abilities. While distinct in origin, these models complement each other by capturing unique yet interrelated aspects of ER (Tull & Aldao, 2015). We operationalized the process model through investigator-rated behavioral ER difficulties observed in children with and without OCD during a frustration task, and the multi-dimensional model through self-report and parent-report of perceived child ER difficulties.

Additionally, we assessed children's self-rated frustration levels before and after the frustration task, and measured HRV before, during, and after the task. Based on previous research, we hypothesized that children with OCD, compared to non-clinical controls, would (i) report greater ER difficulties (with similar results for parent-report), (ii) show greater behavioral indication of ER difficulties during performance of the frustration task, and (iii) report exaggerated increases in frustration in response to the task relative to baseline frustration. In addition, given the scarcity of research in HRV and pediatric OCD, we explored (iv) whether children with OCD demonstrate exaggerated HRV responses to the frustration task compared to non-clinical controls.

2. Methods

2.1 Participants

The present study was a sub-study of a larger randomized controlled trial designed to test treatment efficacy of cognitive behavioral therapy (CBT) for 121 children with OCD (The TECTO trial; [clinicaltrials.gov NCT03595098](https://clinicaltrials.gov/ct2/show/study/NCT03595098); Pagsberg et al., 2022). The present study was based on data collected at baseline comparing data from unmedicated children with OCD participating in the treatment trial with data from a group of non-clinical controls who did not receive an intervention. For details on recruitment, see Uhre and Ritter et al. (2023). We used the following inclusion criteria for children with OCD: 1) age 8 to 17 years (both included); 2) Moderate to severe OCD as primary diagnosis according to ICD-10 (World Health Organization, 2019) using item criteria from the Kiddie Schedule for Affective Disorders and Schizophrenia - Present and Lifetime version (K-SADS-PL) for DSM-IV (Kaufman et al., 1997); 3) OCD symptom severity score ≥ 16 on the Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS) total score (Scahill et al., 1997). Exclusion criteria were; 1) full scale IQ ≤ 70 (Wechsler, 2008, 2014); 2) having received CBT, psychoeducation and relaxation therapy, antidepressants, or antipsychotics within the past six months prior to enrollment; 3) meeting ICD-10 diagnostic criteria for schizophrenia, other psychotic disorder, mania, bipolar disorder, substance dependence disorder, or pervasive developmental disorder (except for Asperger's syndrome). For the non-clinical control group, we recruited 90 children matched on age and sex from the

Danish Central Person Registry. Here, exclusion criteria were: 1) any current or lifetime psychiatric diagnoses verified with K-SADS-PL; 2) meeting any exclusion criteria used for children with OCD.

2.2 Procedures

This study was approved by the Regional Committee on Health Research Ethics (journal number H-18010607) and The Knowledge Centre on Data Protection Compliance in The Capital Region of Denmark (VD-2018-263, I-Suite no.: 6502). Children with OCD and non-clinical controls were screened by trained clinicians (psychologists or MDs specializing in child and adolescent psychiatry, all with at least one year of supervised experience in child and adolescent psychiatry), or by trained psychology students working under supervision. All assessors were certified in the diagnostic instruments used. Diagnoses for the children with OCD were established together with a specialist in psychiatry at the outpatient clinic. Written consent was obtained from the parents/legal caretakers. After inclusion in the trial, the child took part in a 4-hour baseline assessment including the ER paradigm alongside other procedures that were part of the larger trial and are thus not reported here. The full ER paradigm included self-report and parent-report of child ER difficulties, a frustration task with investigator-rated ER, self-rated frustration before and after the task, and measures of HRV before, during and after the task.

2.3 Self-report and parent-report of child emotion regulation difficulties

The Difficulties in Emotion Regulation Scale (DERS) (Gratz & Roemer, 2004) is a self-report questionnaire comprising 36 items designed to capture the frequency of ER difficulties on a five-point Likert scale from 1 (*almost never*) to 5 (*almost always*). It comprises six subscales: (1) non-acceptance of negative emotional responses, (2) difficulties engaging in goal-directed behavior when experiencing negative emotions, (3) difficulties controlling impulses when experiencing negative emotions, (4) lack of awareness of emotional responses, (5) limited access to ER strategies perceived as effective, and (6) lack of clarity of emotional responses. The DERS has been validated with children from the age of 11 years (Neumann et al.,

2010) and used extensively in studies of clinical and non-clinical youths, yielding sound psychometric properties (Aune et al., 2023; Kvadsheim et al., 2020; Sousa et al., 2023; Yazici & Yazici, 2019). Self-report and parent-report versions show good internal consistency (Cronbach's $\alpha = .81$ and $.84$, respectively) (ibid., Bunford et al., 2020). However, mounting evidence has demonstrated weak psychometric properties for the subscale assessing lack of awareness of emotional responses (Bardeen et al., 2012; Hallion et al., 2018; Neumann et al., 2010; Yap et al., 2018). Thus, we removed this subscale from analyses. In our study, children aged 11 years and above and parents of children from the entire sample were invited to complete the Danish version of the DERS on child ER difficulties (Bender et al., 2015). In the present study, Cronbach's α for DERS was assessed for the individual subscales for self-report (.85 Non-acceptance, .89 Goals, .89 Impulse, .87 Strategy .73 Clarity) and parent-report (.89 Non-acceptance, .93 Goals, .92 Impulse, .94 Strategy, .81 Clarity).

2.4 Frustration task: Investigator-rated emotion regulation difficulties

The Tangram Emotion Coding Manual (TEC-M) is a standardized coding scheme to evaluate the child's ability of ER during a frustration task (Hagstrøm et al., 2019). The task is a five-minute complex Tangram puzzle with the child and one parent present. Within the given time frame, the child is instructed to solve as many of the six available puzzles as possible. The parent receives the solution booklet, is instructed not to reveal the solutions to the child, and only to assist if "truly necessary". Following instructions, the assessor leaves the room, and the entire five-minute test is recorded on video for subsequent behavioral coding. The task is meant to be difficult and frustrating even for adults and thus the aim of the task was to observe the child's behavior when facing substantial difficulties. The primary outcome of TEC-M is the EmReg score, which indicates the overall ER ability of the child during the five-minute task. The EmReg is scored on a five-point Likert scale from 1 (*very poor ER abilities*) to 5 (*excellent ER abilities*). To inform the EmReg score, the TEC-M provides 19 codes, which describe various aspects of ER processes, based on the ER process model by Gross (1998) as well as parental behavior and parent-child-interaction (see Supplementary materials, p. 2). Items are scored on frequency (never, rarely, sometimes, often) and intensity

(mild, moderate, marked). All items are investigator-rated on anchored scales in accordance with the manual. The TEC-M has been validated and employed in studies assessing children from clinical as well as non-clinical groups (Hagstrøm et al., 2021; Spang et al., 2022). In this study, only the primary outcome, the EmReg, was used. Videos were coded by trained investigators and consensus codings were frequently carried out to ensure consistency in coding.

2.5 Frustration task: Self-rated frustration

We used a Visual Analogue Scale (VAS) to assess self-rated levels of frustration before and after the frustration task. Scores range from 0 (no frustration) to 10 (highest level of frustration) (see Supplementary materials p. 2).

2.6 Frustration task: Psychophysiological measures

We recorded the child's heart rate for five minutes before, during, and after the task. During baseline and the recovery period after the task, the child and parent were instructed to sit still without communicating. They had to refrain from food and caffeinated beverages two hours prior to the task. Heart rate data was acquired via an electrocardiogram using the eMotion Faros 180° device (Mega Electronics Ltd., Pioneerinkatu, Finland). Two pre-lubricated disposable electrodes were placed on the child, one just below the right clavicle and one on the left side of the chest below the 12th rib. The sampling rate ranged from 250 to 500 Hz (details in Supplementary materials p. 3). We imported raw heart rate data into the Kubios HRV Scientific 4.0.2 software (Tarvainen et al., 2014). Data were interpolated at 2000Hz and initially preprocessed with the automatic R-peak detection based on the Pan-Tompkins algorithm (Tarvainen et al., 2014). This was followed by a visual inspection to identify and correct possible artifacts. For information on missing and excluded recordings, see Supplementary materials p. 5. For the current study, we extracted three physiological parameters (Quintana et al., 2016). The time-domain parameters were mean heart rate measured in beats per minute and the root mean square of successive differences of R-R intervals (RMSSD).

The frequency-domain parameter was the high frequency HRV (HF-HRV) calculated by the Fast Fourier Transform using Welch's Periodogram (window width = 300 s, 50% overlap, resampled at 4 Hz). The HF-HRV band was set at 0.15-0.4 Hz.

3. Statistical Analyses

Analyses were carried out in IBM SPSS Statistics version 28 (IBM Corp. Released 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp.). The sample size for OCD patients was determined based on the minimal relevant difference on OCD symptomatology at end-of-treatment in the original TECTO RCT (a total of 130 patients). We aimed for an equivalent number of sex- and age-matched non-clinical controls. Baseline ER data was available for 121 OCD patients and 90 controls. With an a priori alpha level of .05 and power of .80, we can detect a medium sized effects Cohen's $d = 0.5$ (Serdar et al., 2021). Demographic characteristics of the groups were compared using Student's t -tests for numerical data (age and IQ) and chi-square test for categorical data (sex). Self-report and parent-report of child ER difficulties were compared between children with and without OCD and their parents, respectively, using multivariate analyses of variance (MANOVA). If more than 25% of items on any scale were missing, the questionnaire data from that participant was removed from analyses (see Supplementary materials p. 3). For missing items below 25%, prorating procedures were used by taking the mean of the available scores and multiplying them by the number of items on the scale (see Supplementary materials p. 3). Due to unequal sample sizes and violation of the assumption of homogeneity of covariance matrices, Wilk's Lambda (denoted with Λ) was reported for the main results and Games-Howell post hoc procedure was selected for the subsequent pairwise comparisons. Student's t -test was run to compare the investigator-rated ER between children with and without OCD. For the self-rated frustration assessments, we conducted a repeated measure ANOVA (rmANOVA) to assess differences in frustration ratings between children with and without OCD across time, before and after the frustration task. Similarly, we assessed differences in psychophysiology before, during, and after the task using rmANOVAs. Due to heterogeneous variability between the groups, we report Wilk's lambda in all rmANOVAs. HRV indices (RMSSD and HF-HRV) had positively skewed

distributions and were therefore transformed to the natural logarithm (ln) to obtain normal distributions. For 12 children (7 with and 5 without OCD) the ECG derived respiratory rates fell outside the predefined HF-HRV band (0.15-0.4 Hz). Therefore, we ran a sensitivity analysis without HRV data from these children. This did not impact our findings and data from these 12 participants are thus kept in the main HRV analyses (see Supplementary materials p. 5).

4. Results

4.1 Participant characteristics Nationality was based on self-report. Ethnicity was not assessed as this is not routine practice to register in the Danish health care system. Children with OCD and non-clinical controls were comparable in terms of age and sex; however, children with OCD demonstrated lower IQ scores compared to non-clinical controls (Table 1). Of the 121 children with OCD, 71 had at least one comorbid disorder (Table 1), 21 were taking medication for other somatic or psychiatric conditions thought to have an impact on HRV (Buventol; Budesonid; Salbutamol; Terbutali; Certirizin, $n = 10$ (asthma); Melatonin, $n = 9$ (sleep disorder); methylphenidate, $n = 2$ (attention-deficit hyperactivity disorder); Valproate, $n = 1$ (epilepsy)). The number of children included in the analyses varied across measures due to differences in missing data patterns, which arose from COVID-19 adaptations to procedures, participant preferences, measure-specific eligibility criteria, and data quality exclusions, with each measure independently retained or excluded (for details on missing data see Supplementary materials pp. 3-5).

Table 1. Demographic and clinical characteristics

Baseline characteristics	OCD	Controls	<i>p</i>	<i>d</i>
Number of participants	121	90		
Sex			.795	
Female (%)	61 (50.40)	47 (52.20)		
Male (%)	60 (49.60)	43 (47.80)		
Mean age in years (<i>SD</i>)	13.21 (2.85)	12.93 (2.78)	.486	.097
Mean IQ ¹ (<i>SD</i>)	98.15 (13.12)	106.02 (13.93)	<.001*	-.584
Nationality				
Danish (%)	98 (81.00)	69 (75.60)		
Other (%)	10 (9.30)	3 (3.30)		
Missing (%)	13 (10.70)	19 (21.10)		
Mean CY-BOCS ² total score (<i>SD</i>)	25.96 (4.96)			
Co-occurring psychiatric disorders				
Asperger's Syndrome (F84.5)	16 (13.20)			
Anxiety disorders ³ (F40.0, 40.1, 40.2, 41.1, and 93.8)	17 (14.00)			
Adjustment disorder ⁵ (F43.23)	16 (13.20)			
Tic disorders (F95)	14 (11.60)			
Other ⁶	20 (16.53)			
Total with at least one co-occurring disorder	71 (59.5)			

Note. ¹IQ measured as the General Ability Index from the Wechsler Scales; ²Children's Yale-Brown Obsessive Compulsive Scale; ³Anxiety disorders 40.0 Agoraphobia, 40.1 Social phobia, 40.2 Specific (isolated) phobias, 41.1 Generalized anxiety disorder, 93.8 Other childhood emotional disorders; ⁵Adjustment disorder with mixed anxiety and depressed mood (F43.23); ⁶Other: F30-F39 Mood [affective] disorders (*n* = 1), F50-59 Behavioral syndrome associated with physiological disturbances and physical factors (*n* = 4), F60-69 Disorders of adult personality and behavior (*n* = 1), F80-89 (*n* = 5), F90.1-98.9 Behavioral and emotional disorders with onset usually occurring in childhood and adolescence (*n* = 9)

4.2 Self-report and parent-report of child emotion regulation difficulties

The overall MANOVA on self-reported ER difficulties showed a significant difference between groups ($\Lambda = .776$, $F(5,133) = 7.69$, $p < .001$; $\eta_p^2 = .224$). An examination of between-subject effects revealed that children with OCD reported more ER difficulties on four out of the five DERS subscales ($F(1,137) = 10.02$ to 27.16 , $p < .01$; $\eta_p^2 = .068$ to $.165$) (Table 2). The overall MANOVA on the parent-reports of child ER difficulties showed significant differences between groups ($\Lambda = .575$, $F(5,158) = 23.32$, $p < .001$; $\eta_p^2 = .425$). An examination of between-subject effects revealed that parents reported children with OCD to have significantly more ER difficulties on all five subscales compared to parents of non-clinical controls ($F(1,162) = 2.10$ to 3.49 , $p = <.001$; $\eta_p^2 = .207$ to $.369$) (Table 2).

Table 2. Self-report and parent-report of child ER difficulties

Subscales	Children				Parents			
	OCD	Controls	<i>p</i>	η_p^2	OCD	Controls	<i>p</i>	η_p^2
	(<i>n</i> = 80)	(<i>n</i> = 59)			(<i>n</i> = 103)	(<i>n</i> = 61)		
	<i>Mean (SD)</i>				<i>Mean (SD)</i>			
Nonacceptance	11.17 (5.00)	9.71 (3.56)	.058	.026	12.60 (4.34)	8.12 (2.34)	<.001	.254
Goals	15.72 (4.71)	12.32 (4.13)	<.001	.125	17.45 (4.66)	11.86 (3.87)	<.001	.326
Impulse	12.82 (5.41)	8.74 (3.02)	<.001	.165	14.89 (5.74)	9.32 (3.11)	<.001	.231
Strategies	18.16 (6.90)	13.20 (3.66)	<.001	.155	21.38 (6.78)	12.17 (3.76)	<.001	.369
Clarity	10.18 (3.20)	8.57 (2.58)	.002	.068	10.84 (3.38)	7.72 (2.06)	<.001	.207

Note. Test of between-subject effects from each MANOVA for self-report and parent-report of DERS, respectively; η_p^2 = partial eta squared

4.3 Frustration task: Investigator-rated emotion regulation difficulties

The ability to regulate emotions during the task was significantly lower in children with OCD ($M = 3.03$, $SE = .08$) compared to non-clinical controls ($M = 3.30$, $SE = .08$), ($t(179) = -2.249$, $p = .026$, 95% CI [- .508, -.033], $d = .33$) (Table 3 and Figure 1).

4.4 Frustration task: Self-rated frustration

For the self-rated frustration assessment before and after the task there was a significant main effect of task, ($\Lambda = .67$, $F(1,191) = 93.944$, $p < .001$, $\eta_p^2 = .33$) due to both children with and without OCD reporting more frustration after the task relative to baseline. There was also a significant main effect of group ($F(1,191) = 18.74$, $p < .001$, $\eta_p^2 = .089$) in that children with OCD both before and after the task reported more frustration compared to non-clinical controls. However, there was no significant interaction between task and group ($\Lambda = .997$, $F(1,191) = .62$, $p = .431$, $\eta_p^2 = .003$), indicating that children with and without OCD did not experience their level of frustration differentially affected by the task (Table 3 and Figure 1).

4.5 Frustration task: Psychophysiological measures

The analysis of heart rate revealed a main effect of task ($\Lambda = .585$, $F(2,179) = 63.582$, $p < .001$, $\eta_p^2 = .415$) but no main effect of group ($F(1,180) = .637$, $p = .426$, $\eta_p^2 = .004$) or significant interaction effect between task and group ($\Lambda = .998$, $F(2,179) = .178$, $p = .837$, $\eta_p^2 = .002$) (Table 3 and Figure 1). Post hoc pairwise comparisons demonstrated that children in both groups had significantly higher HR during task compared to baseline. Further, a significant decrease in HR was observed in both groups for recovery compared to task (Table 4 and Figure 1).

The analysis of lnRMSSD also revealed a main effect of task ($\Lambda = .702$, $F(2,179) = 37.909$, $p < .001$, $\eta_p^2 = .298$) but no main effect of group ($F(1,180) = .151$, $p = .683$, $\eta_p^2 = .001$) or significant interaction effect between task and group ($\Lambda = .999$, $F(2,179) = .105$, $p = .900$, $\eta_p^2 = .001$) (Table 3 and Figure 1). Post hoc pairwise comparisons showed a significant decrease in lnRMSSD for children with and without OCD during task compared to baseline. Further, a significant increase in lnRMSSD was observed in both groups during recovery compared to task (Table 4 and Figure 1).

The analysis of lnHF-HRV also revealed a main effect of task ($\Lambda = .724$, $F(2,179) = 34.170$, $p < .001$, $\eta_p^2 = .276$) but no main effect of group ($F(1,180) = .071$, $p = .790$, $\eta_p^2 = .000$) or significant interaction effect between task and group ($\Lambda = .993$, $F(2,179) = .622$, $p = .538$, $\eta_p^2 = .007$) (Table 3 and Figure 1). Post hoc pairwise comparisons showed a significant decrease in lnHF-HRV for children with and without OCD during task compared to baseline. Further, a significant increase in lnHF-HRV was observed in both groups during recovery compared to task (Table 4 and Figure 1).

Table 3. Investigator-rated behavior, self-rated frustration, and psychophysiology from the frustration task

	Before		During		After					
	OCD	Control	OCD	Control	OCD	Control	Task	Group	Task*Group	
	<i>Mean (SD)</i>						<i>p</i>	<i>d/η_p²</i>	<i>p</i>	<i>η_p²</i>
EmReg			3.03 (.80)	3.30 (.81)			.026	-.33		
VAS	2.77 (2.47)	1.43 (1.50)			4.04 (2.48)	2.92 (2.09)	<.001	.33	<.001	.089
Heart rate (BPM)	79.25 (10.76)	78.18 (10.97)	83.09 (10.88)	81.60 (10.89)	79.72 (10.40)	78.52 (11.40)	<.001	.315	.426	.004
lnRMSSD	3.82 (.63)	3.84 (.58)	3.60 (.52)	3.65 (.51)	3.81 (.62)	3.84 (.58)	<.001	.217	.683	.001
lnHF- HRV	6.79 (1.25)	6.79 (1.23)	6.26 (1.13)	6.39 (1.05)	6.77 (1.25)	6.78 (1.24)	<.001	.198	.790	.000

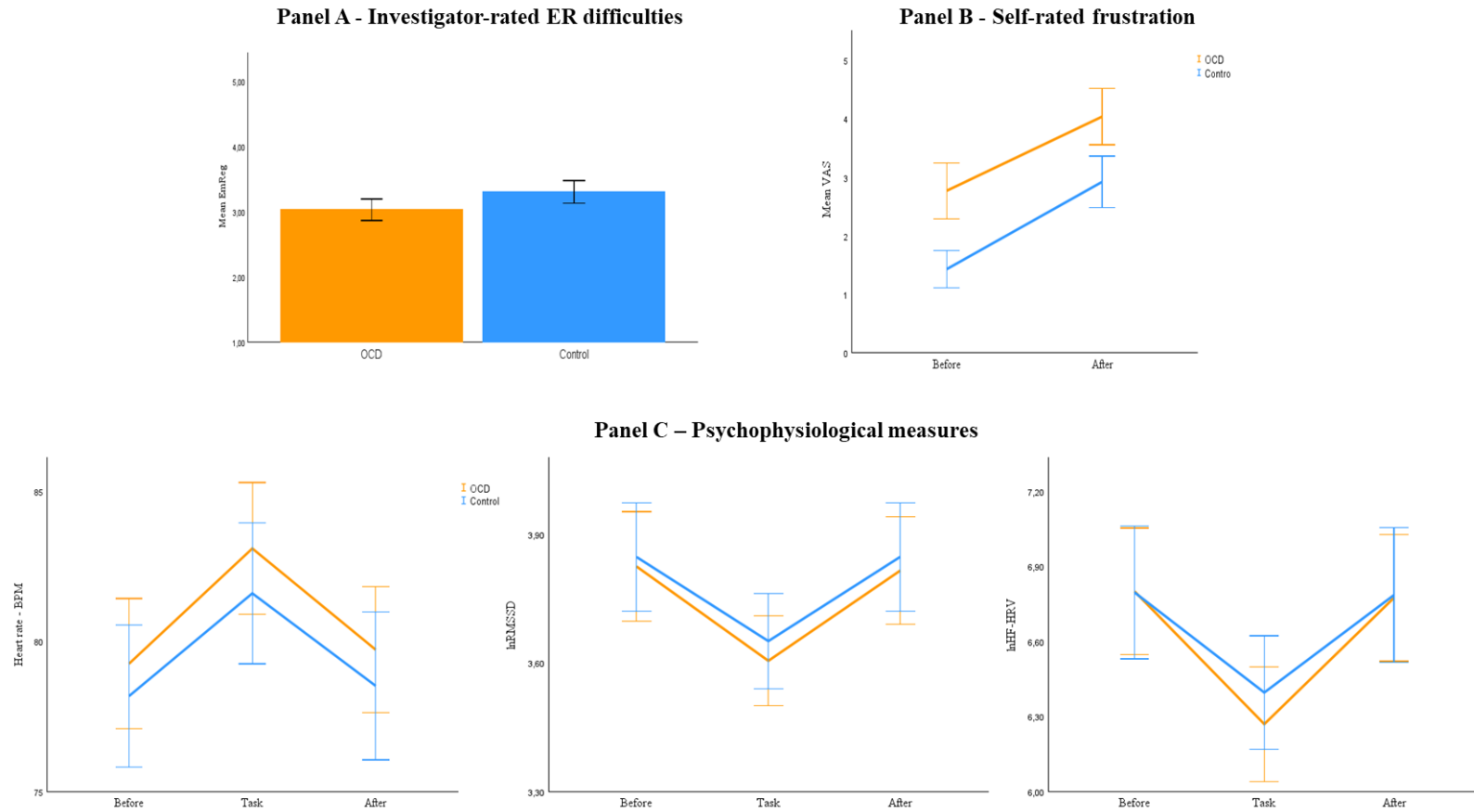
Note. Number of participants: EmReg (OCD: n=98, TD: n=86); VAS (OCD: n=104, Controls: n=89); Heart rate, lnRMSSD, lnHF-HRV (OCD: n=97, Controls: n=85). *d* = Cohen's *d*; η_p^2 = partial eta squared; EmReg: Independent *t*-test with Cohen's *d* as effect size; VAS, heart rate, lnRMSSD, lnHF-HRV: Repeated measure analyses. Group is results from test of between-subjects effect; Task and Task*Group are results from within-subjects effects. For heart rate, lnRMSSD, and lnHF-HRV: Within-subjects effects from repeated measures analyses use Huynh-Feldt due to violation of assumption of sphericity (Mauchly's <.001)

Table 4. Post hoc pairwise comparisons on within-subject psychophysiological measures across conditions

		OCD (n = 97)		Controls (n = 85)	
		<i>p</i>	<i>CI</i>	<i>p</i>	<i>CI</i>
Heart rate (BPM)	Baseline-task	<.001	-4.76, -2.90	<.001	-4.53, -2.45
	Task-recovery	<.001	2.43, 4.30	<.001	2.13, 3.847
	Baseline-recovery	.173	-1.14, .20	.446	-1.10, .48
lnRMSSD	Baseline-task	<.001	.14, .29	<.001	.13, .28
	Task-recovery	<.001	-.28, -.13	<.001	-.26, -.13
	Baseline-recovery	.715	-.04, .06	.846	-.06, .05
lnHF-HRV	Baseline-task	<.001	.34, .69	<.001	.26, .59
	Task-recovery	<.001	-.66, -.34	<.001	-.55, -.22
	Baseline-recovery	.683	-.09, .14	.942	-.13, .14

Note. CI = 95% confidence interval; lnRMSSD = the natural log of root mean square of successive differences; lnHF-HRV; the natural log of high frequency heart rate variability.

Figure 1. Group and within-subject differences on the frustration task



Note. Panel A: mean group differences on EmReg; Panel B: group differences and within-subject differences on self-rated frustration; Panel C: group differences and within-subject differences on HRV measures. Error bars= SD

5. Discussion

We conducted a multi-informant and multi-method examination of ER difficulties in children with OCD to investigate whether these measures differed from non-clinical controls. The study yielded four key findings: (i) self-report and parent-report of child ER difficulties were elevated for children with OCD compared to non-clinical controls; (ii) children with OCD demonstrated more ER difficulties during the frustration task compared to non-clinical controls as rated by investigators; (iii) children with OCD rated significantly more frustration before and after performing the frustration task compared to non-clinical controls. However, their frustration response did not increase significantly more by task performance compared to non-clinical controls. Finally, (iv) all children, regardless of group, demonstrated significant

psychophysiological changes during the frustration task, with no discernible group differences in the magnitude of these changes.

Our finding on more self-reported ER difficulties in children with OCD align with theoretical accounts from the multi-dimensional model by Gratz and Roemer (2004) as well as previous empirical work observing significantly more self-reported ER difficulties in children with OCD compared to non-clinical controls (Bender et al., 2015; Yazici & Yazici, 2019; Öztürk et al., 2023). A recent systematic review, including mainly studies in adult OCD, suggested that the ER sub-domain of “accepting negative emotional responses” was most strongly related to obsessive-compulsive symptomatology (See et al., 2022). Such suggestions have also been put forward in the pediatric literature (Yazici & Yazici, 2019; Öztürk et al., 2023). Notably, in our study, nonacceptance of negative emotions was the only domain in which children with OCD did not indicate more ER difficulties than non-clinical controls. A potential explanation for this could be that to respond adequately on this subscale, children need relatively good emotional insight and meta-emotional abilities. Studies have suggested that these abilities are impaired in OCD (Bender et al., 2015; Smith et al., 2012; Yazici & Yazici, 2019). Importantly, more research is needed to extrapolate the clinical implications of our finding. Furthermore, future research could examine if responses on the subscale of emotional acceptance are particularly driven by individual characteristics such as age, sex, or emotional insight and understanding. To our knowledge, only one parent-report study has included a non-clinical comparison group to examine differences in children’s ER difficulties (Sukhodolsky et al., 2005). Our results align with this study by showing that parents of children with OCD report higher levels of ER difficulties in their children, compared to parents of non-clinical controls.

The behavioral findings from the frustration task extend the questionnaire data by confirming that the ER difficulties experienced by children and parents are also present in the behavioral strategies used during a frustration task, albeit to a lesser extent. Third, even though children with OCD did not report significantly more frustration due to the task, they reported significantly more frustration both before and after the task compared to non-clinical controls. This is consistent with previous studies on questionnaire data, suggesting elevated negative emotions to be part of the clinical presentation of pediatric OCD (Guzick

et al., 2021; Krebs et al., 2013). Fourth, our exploratory analyses of HRV indices are consistent with the only two studies published on HRV in children with OCD. They suggest that HRV does not significantly differ in children with and without OCD at rest (Rozenman et al., 2022) or during a task with mildly stressful auditory probes (Zahn et al., 1996). Similarly, our results indicate that the ER difficulties reported and displayed by children with OCD are not expressed in terms of altered autonomic functioning. Instead, our results suggest that children with OCD display normative HRV patterns, comparable to non-clinical controls, during both rest and challenge.

Our findings demonstrated convergence across self-report, parent-report, and behavioral indices, consistently showing greater ER difficulties in children with OCD compared to non-clinical controls. The questionnaires reflected the multi-dimensional model of ER, while the behavioral indices captured ER strategies. These findings offer support for the bidirectional loop suggested by Tull and Aldao (2015), in which perceived ER abilities and ER strategies mutually influence one another. Future cross-sectional studies could refine the findings by exploring the detailed relationship between perceived abilities and specific strategies. Longitudinal studies could further explore whether developing mastery of flexibly applying ER strategies is the mechanistic target of treatment, with improvements in perceived ER abilities as a key outcome (Mazefsky et al., 2021).

Regarding HRV as a psychophysiological marker of ER, our findings demonstrated HRV reductions during the frustration task. However, no significant group differences were observed between children with and without OCD during the task, and resting-state HRV was also comparable between groups. Although HRV is often proposed as a transdiagnostic marker of ER difficulties (Beauchaine, 2015), a recent systematic review and meta-analysis found no consistent associations between ER deficits and autonomic functioning in youth psychopathology (Bellato et al., 2024). Moreover, emerging theories suggest that autonomic responses, including HRV, may depend more on the context of emotional experiences than the specific emotion itself (Siegel et al., 2018; Ventura-Bort et al., 2022). In our study, the frustration task was conducted in a dyadic context with one parent present. It is possible that children with OCD, who may rely heavily on their parents during distress (Norman et al., 2015), experienced a soothing effect from the parent's presence.

This could have helped them regulate their emotions and normalize HRV. Although this is all speculative, future research could explore the role of parental presence in affecting children's autonomic patterns during emotion regulation. For example, conducting the frustration task twice – once with a parent present and once with an investigator present – could help disentangle the influence of parental support. The convergence and divergence of findings across modalities underscore the complexity of assessing ER. They highlight the need for integrative approaches that consider both contextual influences and the interplay of multiple modalities to deepen our understanding of emotion regulation in youth.

The study further highlights important questions for future research to address. First, considering the low to moderate levels of ER difficulties associated with pediatric OCD in this study: to what extent are ER difficulties in pediatric OCD clinically relevant? How do OCD symptom severity and the various measures of ER difficulties relate, and are any specific parameters (e.g., age, sex, symptom dimensions, or comorbidity status) driving the potential relationship? Finally, considering that CBT with exposure and response prevention is the recommended first line treatment for children with OCD (Fineberg et al., 2020), to what extent do the child's ER difficulties impact their ability and willingness to engage in the exposures – both in session and during homework?

The current findings should be interpreted in the context of some limitations. First, we included patients with a variety of comorbidities known to be associated with ER difficulties, which may confound our conclusions on difficulties related specifically to OCD. Nonetheless, comorbidities are highly prevalent in OCD (Sharma et al., 2021), and thus including children with multiple comorbid psychiatric disorders enhances the representativeness of the study. Second, although children were matched on age and sex, they were not comparable on IQ. The analyses in the present study did not correct for this difference as the causal mechanisms and the interrelations between IQ, ER, and OCD has not been determined and thus controlling for IQ could potentially introduce bias in the analyses (Dennis et al., 2009). Further, it should be noted that the mean IQ for children with OCD was well within normal ranges. Third, clinical investigators rating the frustration task with TEC-M were not blinded to the child's status as patient vs non-clinical control. Despite strongly emphasizing unbiased coding, we acknowledge that the unblinding of patient status may

inadvertently influence coding decisions. Thus, future work using the TEC-M should pursue blinding of investigators to ensure unbiased results. Fourth, a segment of children with OCD ($n = 21$) received medications for conditions other than OCD, some of which are thought to affect heart rate. Medication status for the non-clinical controls was unknown, except according to exclusion criteria. Fifth, we did not directly record respiration in this study. As breathing patterns change as a function of age and possibly as a function of diagnostic status, it may have confounded particularly the HF-HRV measurements in this study (Quintana et al., 2016). Sixth, the DERS has only been validated for children aged 11 and older (Neumann et al., 2010), therefore children aged 8–10 years were unable to provide self-reports on emotion regulation difficulties. Consequently, data for this age group rely solely on parent reports, which may introduce bias or limit the perspective on emotion regulation in younger children. Future studies should consider alternative approaches to assessing self-reported emotion regulation in this age group. Seventh, to handle missing questionnaire data, we used prorating, which may introduce bias and reduce statistical power. Theoretical accounts suggest that prorating is reasonable when the following assumptions are met: (1) a substantial proportion of items (and never fewer than half) are used to calculate the scale score, (2) the item-total correlations are consistent, and (3) the scale demonstrates high internal reliability (Graham, 2009). We have checked and verified that these assumptions hold in our dataset in our data. Nevertheless, future studies would benefit from using more robust methods for handling missing data, such as full information maximum likelihood, as recommended by Mazza et al. (2015). Finally, our sample size may impede generalizability of findings given that we could not detect effect sizes smaller than $d = 0.5$ with sufficient statistical power.

The present study also has several strengths. First, we examined a large, clinically well-characterized group of children with moderate to severe OCD through a multi-informant and multi-method approach. Second, we ensured representativeness of real-life clinical populations by including children with a broad range of comorbidities. Third, patients were medication-naïve, which minimizes the confounding effects of medication on OCD symptoms, thereby contributing to clearer understanding of emotion regulation difficulties in OCD. Fourth, patients were compared to a large group of non-clinical controls, who were screened with K-SADS to ensure absence of prior or current mental illness and matched on sex and age.

Finally, our psychophysiological work contributes to the scarce research previously conducted on pediatric OCD by including a larger group of children and adhering to current guidelines on data preparation and HRV calculation (Quintana et al., 2016).

6. Conclusion

In conclusion, the present study is the first to employ a multi-informant and multi-method approach to examine ER in children with OCD concurrently. This comprehensive investigation provides a more nuanced understanding of ER difficulties in pediatric OCD suggesting that challenges in ER are identified by the children and their parents and are observable to investigators. Interestingly, these difficulties were not expressed in terms of autonomic functioning. Future longitudinal research should examine the clinical relevance of ER difficulties in pediatric OCD and investigate to what extent they affect treatment, thus constituting a potential target for improving OCD therapy.

Declaration of Competing Interest

The authors report that they have no conflict of interest.

Data Availability

After results from the present and planned studies have been published, we will make a deidentified dataset used for the analyses publicly available on the EU ZENODO database.

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Appendix A. Supporting information

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Supplementary materials: Emotion regulation difficulties in children and adolescents with obsessive-compulsive disorder: A multi-informant and multi-method study

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1. Methods

1.1 TEC-M scoring sheet

TEC-M Scoring Sheet				
Parent	The Tangram Construction Task	Intrusive-ness		
		Control		
		Avoidance		
		Verbal reappraisal		
		Support sensitivity		
Child	The Tangram Construction Task	Control		
		Avoidance/resignation		
		Narration		
		Verbal reappraisal		
		Reassurance seeking		
		Emotional warmth		
Frequency: Never (0), Rarely (1), Sometimes (2), Often (3) Intensity: Mild (1), Moderate (2), Marked (3)				
Notes:				
ID: Date: Coder: Test adm.: Time:				

1.2 The Visual Analogue Scale

Instruction: "Please, indicate how frustrated you feel right now on a scale from 0 to 10 with 0 being not at all frustrated and 10 being extremely frustrated"

0	1	2	3	4	5	6	7	8	9	10
Not at all		A little			Moderately			A lot		Worst possible

2. Data pre-processing

2.1 Prorating of missing items on the DERS

	OCD	Controls
Children	15	4
Parents	10	1

2.2 Procedures for parent-reports of child ER difficulties

A mean score was calculated when two parents had reported on DERS. If only one parent has reported on the DERS then those score were used. Thus, for patients, 84 parent-reports were a mean score from two parents and 19 parent-reports were scores from a single parent. For controls 34 parent-reports were mean scores from two parents and 27 parent-reports were scores from a single parent.

2.3 Details on the range in sampling rate in psychophysiological measures

The sampling rate employed for data acquisition was established at 500 Hz. Due to an inadvertent error, a substantial number of healthy control participants had their sampling rate configured at 250 Hz. However, it is important to note that this deviation should not have any detrimental effects on the quality of the data or subsequent analytical procedures, as the Kubios software, by default, employs interpolation techniques to enhance the temporal resolution of R-wave detection, effectively interpolating R-waves at 2000 Hz. Consequently, the ECG data was imported into the Kubios HRV Scientific 4.0.2 software, as outlined in the study conducted by Tarvainen et al. (2014).

3. Missing and number of participants included in analyses

3.1 The Difficulties in Emotion Regulation Scale

Self-report ER difficulties	Patients	Controls
	121	90
Under 11 years of age	32	29
Eligible for questionnaire	89	31
Reason for missing		
Covid	1	0
Admin error	5	1
More than 25% missing items on any scale	1	1
Test day shortened	2	0
Included in analyses	80	59

Parent-reports of child ER difficulties	Patients	Controls
Pairs of parents	121	90
Reason for missing		
Reason unknown	18	29
Included in analyses	103	61

3.2 The Frustration paradigm

Investigator-rated ER difficulties (EmReg)	Patients	Controls
	121	90
Reason for missing		
No consent to video	9	1
Covid	5	0
Admin error	6	1
Not speaking Danish during the task	2	2
Test day shortened	1	0
Included in analysis	98	86

Self-rated frustration (VAS)	Patients	Controls
	121	90
Reason for missing		
No consent to video	9	1
Covid	5	0
Admin error	2	0
Test day shortened	1	0
Included in analysis	104	89

Psychophysiological measures (HRV)	Pre		Task		Post	
	OCD	Controls	OCD	Controls	OCD	Controls
	121	90	121	90	121	90
Reason for missing						
No consent to video	9	1	9	1	9	1
Covid	5	0	5	0	5	0
Admin error	1	0	1	0	3	0
Do not want HRV	2	0	2	0	2	0
Test day shortened	1	0	1	0	1	0
Reason unknown	1	1	1	1	1	1
HRV quality too low	3	0	3	1	3	1
Included in analyses	99	88	99	87	97	85

4. Sensitivity analyses on psychophysiological measures

12 participants removed as ECG derived respiration fell outside the predefined HF-HRV band (0,15-0,4 Hz)

4.1 Heart rate

The sensitivity analysis of heart rate with 12 children removed revealed a main effect of task ($\Lambda = .593$, $F(2,167) = 57.23$, $p < .001$, $\eta_p^2 = .407$) but no main effect of group ($F(1,168) = .15$, $p = .697$, $\eta_p^2 = .001$) or significant interaction effect between time and group ($\Lambda = .997$, $F(2,167) = .28$, $p = .79$, $\eta_p^2 = .003$).

4.2 lnRMSSD

The sensitivity analysis of lnRMSSD with 12 children removed revealed a main effect of task ($\Lambda = .712$, $F(2,167) = 33.69$, $p < .001$, $\eta_p^2 = .288$) but no main effect of group ($F(1,168) = .01$, $p = .920$, $\eta_p^2 = .000$) or significant interaction effect between time and group ($\Lambda = .996$, $F(2,167) = .35$, $p = .70$, $\eta_p^2 = .004$).

4.3 lnHF-HRV

The sensitivity analysis of lnHF-HRV with 12 children removed revealed a main effect of task ($\Lambda = .729$, $F(2,167) = 31.04$, $p < .001$, $\eta_p^2 = .271$) but no main effect of group ($F(1,168) = .00$, $p = .947$, $\eta_p^2 = .000$) or significant interaction effect between time and group ($\Lambda = .986$, $F(2,167) = 1.21$, $p = .30$, $\eta_p^2 = .014$).

Study IV: The OCD treatment study

Implications of emotion regulation difficulties for psychotherapy in pediatric OCD

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Title: Implications of emotion regulation difficulties for psychotherapy in pediatric OCD

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Abstract

Background: Pre-treatment emotion regulation difficulties are extensively reported in pediatric obsessive-compulsive disorder (OCD), yet information regarding whether they are addressed by current interventions and/or moderate treatment outcomes, particularly for different interventions (e.g., cognitive-behavioral therapy with exposure and response prevention or (CBT-ERP) family-based psychoeducation with relaxation training (FPRT)), is lacking.

Methods: Seventy-nine adolescents with OCD (11-17 years) completed the Difficulties in Emotion Regulation Scale (DERS) before and after being randomized to 16 weeks of either family-based CBT-ERP (FCBT) or family-based psychoeducation with relaxation training (FPRT). A cohort of 59 age- and sex-matched adolescents without psychiatric disorders was included to establish temporal stability of emotion regulation and a normative reference level on the DERS.

Results: As a treatment outcome, adolescents in the FCBT group demonstrated post-intervention improvements in emotion regulation, whereas those in FPRT group did not. Treatment outcomes were neither moderated by pre-treatment emotion regulation difficulties nor mediated by changes in these difficulties. Sensitivity analyses on treatment completers yielded similar results.

Conclusions: The findings confirm emotion regulation difficulties as modifiable targets for therapy in pediatric OCD and suggest that FCBT is effective in improving emotion regulation abilities, while FPRT is not.

Keywords: Obsessive-compulsive disorder, emotion regulation, cognitive behavioral therapy, exposure and response prevention, relaxation training, randomized clinical trial

Introduction

Obsessive-compulsive disorder (OCD) is a debilitating disorder affecting up to 3% of children and adolescents (Stiede et al., 2024). OCD is characterized by obsessions - repetitive thoughts, urges or images that cause significant distress - and compulsive covert or overt behavior, performed to neutralize the distressing thoughts and beliefs (ICD-11, 2019). Cognitive behavioral therapy (CBT), including exposure and response prevention (ERP), is the first-line treatment for pediatric OCD (Fineberg et al., 2020). Robust empirical evidence supports the efficacy of CBT in alleviating OCD symptoms in children and adolescents (Cervin et al., 2024; Uhre et al., 2020; Öst et al., 2016). However, up to 40% show partial or no response (Farrell et al., 2023). Additionally, evidence-based treatments like ERP may be difficult to translate into real-world clinical settings (Racz et al., 2024; Reid et al., 2018; Schneider et al., 2020). A survey of 257 child practitioners reported ERP to be used only 30% of the time in treating pediatric OCD, instead favoring techniques such as relaxation training (Reid et al., 2018). Clinical trials using relaxation as an active placebo comparator show that relaxation reduces OCD symptoms in children and adolescents, although less efficiently than CBT (Freeman et al., 2014; Piacentini et al., 2011; Russman Block et al., 2023). Thus, it is useful for research targeted at improving OCD treatments to consider both CBT-ERP and relaxation-based treatments when considering intervention impacts and potential moderators.

Emotion regulation difficulties have received increased attention as modifiable targets in psychotherapies across diagnoses (Sloan et al., 2017), with a meta-analysis suggesting that shared therapeutic components - such as goal-setting and psychoeducation - may impact emotion regulation difficulties (Helland et al., 2022). In pediatric OCD, pre-treatment emotion regulation difficulties are well-documented (Berman et al., 2020; Khosravani et al., 2020; McKenzie et al., 2020b; Yazici & Yazici, 2019), yet their role in treatment remains unclear. Studies examining emotion regulation difficulties as a treatment outcome have reported improvements following treatment (Krebs et al., 2013; McGuire et al., 2013). However, research on pre-treatment emotion regulation difficulties as predictors or moderators of treatment outcomes has yielded mixed results. Some studies indicate that children and adolescents with pre-treatment emotion regulation difficulties experience less reduction in OCD symptoms during and after treatment (McKenzie et al., 2020a; McNamara et al., 2014), while others find no such association (Krebs et al., 2013; McGuire et al., 2013). Additionally, there are accounts of pre-treatment emotion regulation difficulties affecting treatment progress (McNamara et al., 2014) and attrition (McGuire et al., 2013).

Current treatment studies on pediatric OCD conceptualize emotion regulation difficulties as low emotional control, emphasizing behavioral dysregulation, such as temper outbursts. While valuable, this approach reflects only one dimension of emotion regulation difficulties and may not capture the full emotional complexity of OCD (Calkins et al., 2013). Emotion regulation difficulties in OCD can also manifest as perfectionism and avoidance (Cervin et al., 2020), as well as challenges with emotional acceptance, clarity,

and refocusing when distressed (Ferrández-Mas et al., 2023; Yap et al., 2018; Yazici & Yazici, 2019). To address this broader range of difficulties, the Difficulties in Emotion Regulation Scale (DERS), developed by Gratz and Roemer (2004), may offer a more comprehensive framework. Here emotion regulation difficulties is defined as impairments in (1) awareness, understanding, and acceptance of emotions; (2) controlling maladaptive behaviors and impulses in response to negative emotions; and (3) employing flexible, context-appropriate strategies to modulate emotional intensity and duration (Gratz & Roemer, 2004).

Despite extensively used in treatment studies for other pediatric psychopathologies (Bjureberg et al., 2023; Defayette et al., 2021; Russell et al., 2019; Stewart et al., 2021), the DERS has yet to be applied in treatment studies on pediatric OCD. Related research in adults with OCD may, however, provide relevant insight. Two studies from the same clinical project using the DERS found that improvements in emotion regulation, particularly impulse control, mediated symptom reduction (Asnaani et al., 2020) and that lower emotional awareness at baseline predicted greater symptom reduction (Bredemeier et al., 2022) in adults with OCD. Applying the DERS conceptualization to address emotion regulation difficulties in pediatric OCD is also theoretically meaningful for interventions using ERP or relaxation techniques. In CBT, difficulties with accepting distress, refocusing on goals, and controlling impulses may hinder the child's ability to engage in exposure exercises and disrupt the imperative learning processes (Craske et al., 2014). In relaxation-based approaches, challenges with emotional awareness may prevent the child from identifying the distress needed to be addressed during the relaxation, while difficulties in emotional acceptance or sustaining focus may lead to resistance or avoidance. These barriers can prevent the child from achieving the intended calming effect thereby reducing the overall effectiveness of the relaxation techniques.

In summary, while pre-treatment emotion regulation difficulties are observed in pediatric OCD, their impact on treatment remains unclear. Additionally, the frequent use of techniques other than evidence-based ERP in real-world clinical settings highlights an evidence-to-practice gap. Typically, interventions incorporate shared psychotherapeutic elements, such as goal-setting and psychoeducation, relevant for addressing emotion regulation difficulties (Helland et al., 2022; Sloan et al., 2017). Given the underexplored role of emotion regulation in pediatric OCD treatment, the value of assessing whether emotion regulation is implicated through shared therapeutic elements or specifically through ERP, the active mechanism in OCD treatment, is clear.

This study aims to explore how emotion regulation difficulties in pediatric OCD serve as outcomes, moderators, or mediators of treatment, with a focus on shared therapeutic elements and the specific role of ERP. Analyses are based on data from a randomized clinical trial comparing family-based CBT with ERP (FCBT) to family-based psychoeducation and relaxation training (FPRT), which to some extent mimics common real-world clinical practices (Pagsberg et al., 2022). While both interventions include goal-setting and psychoeducation, only CBT incorporates ERP as the active ingredient for treating OCD. Additionally,

data from a prospective parallel control study are used to evaluate the stability of emotion regulation and establish a local reference interval for normative emotion regulation.

Methods

Design

This study is part of the randomized clinical trial TECTO (Treatment Effects of Cognitive-behavioral Therapy for Obsessive-Compulsive Disorder) [clinicaltrials.gov NCT03595098](https://clinicaltrials.gov/ct2/show/study/NCT03595098); (Pagsberg et al., 2022). Of the 130 patients from the trial, 79 are included in this study (for flowchart see **Figure 1**). Patients were randomized to 14 sessions of either FCBT or FPRT. The randomization was stratified by age (8 to 12 and 13 to 17 years) and CY-BOCS total score at baseline (16 to 23 (moderate) and 24 to 40 (severe to extreme)). The trial was approved by the Regional Committee on Health Research Ethics (journal number H-18010607, March 2018) and The Knowledge Centre on Data Protection Compliance in The Capital Region of Denmark (VD-2018-263, I-Suite no.: 6502, July 2018). Prior to study enrolment, informed written consent was obtained from the parents/legal caretakers.

Parallel to the trial, we conducted a prospective observational study including sex- and aged-matched adolescents without any psychiatric condition. Of the 90 included as healthy controls, 59 are included in this study (for flowchart see **Figure 1**).

Patients and controls

Patients aged 8 to 17 years were recruited from the Child and Adolescent Mental Health Center (CAMHC), Copenhagen University Hospital – Mental Health Services CPH, Denmark. Inclusion criteria were; 1) OCD as primary diagnosis according to ICD-10 (World Health Organization, 1992) using item criteria from the Kiddie Schedule for Affective Disorders and Schizophrenia – Present and Lifetime version (K-SADS-PL) for DSM-IV (Kaufman et al., 1997); 2) OCD symptom severity score ≥ 16 on the Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS) total score (Scahill et al., 1997). Exclusion criteria were; 1) full scale intelligence quotient (IQ) < 70 (Wechsler, 2008, 2014); 2) receiving CBT, psychoeducation and relaxation therapy, antidepressants, or antipsychotics within six months prior to enrollment; 3) meeting ICD-10 diagnostic criteria for schizophrenia, other psychotic disorder, mania, bipolar disorder, substance dependence disorder, or pervasive developmental disorder (except for Asperger's syndrome). Clinical interviews were conducted with patients and parents separately. Diagnoses were established on clinical conferences at CAMHC by trained clinicians (psychologists or MDs specializing in child and adolescent

psychiatry). For further details see, Pagsberg et al. (2022) and Uhre and Ritter et al. (2023). Of the 130 trial patients, 121 participated in the emotion regulation assessments.

Additionally, we recruited controls from the Danish Central Person Registry, matched by age and sex to patients. Here, exclusion criteria were: 1) any current or lifetime psychiatric diagnoses verified with K-SADS-PL; 2) meeting any exclusion criteria used for children and adolescents with OCD.

Treatment and procedures

Following baseline assessment and eligibility confirmation, patients were randomized to either FCBT or FPRT. Both interventions were manualized (FCBT (Thomsen & Weidle, 2015); FPRT (Piacentini et al., 2011) and consisted of 14 sessions, each 75 minutes long, delivered over 16 weeks. While both interventions involved family participation, psychoeducation, and homework, the primary focus of FCBT was ERP, whereas FPRT emphasized muscle relaxation training and breathing exercises. All therapists delivered both interventions with external fidelity ratings conducted to assess manual compliance, competence, and differentiation (Pagsberg et al., 2022). Trained assessors (clinical psychologists, medical doctors, or psychology students under supervision) who were blind to treatment allocation, conducted clinical assessments at baseline, treatment weeks 4 and 8, end-of-treatment, and 6-months post-treatment. Emotion regulation assessments, including self- and parent reports, behavioral observations, and psychophysiological measures, were conducted at baseline and end-of-treatment. This study focuses on self-reported emotion regulation difficulties.

Measures

OCD symptom severity OCD symptom severity was assessed using the *Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS)* (Scahill et al., 1997). The CY-BOCS is a 10-item clinical administered instrument (total score range 0 to 40) assessing clinical severity of OCD over the previous week. It is considered the gold standard measure for pediatric OCD research and psychometric properties are well-documented with good reliability and validity in children and adolescents (Storch et al., 2004). We defined 'treatment response' as CY-BOCS total score at end-of-treatment whereas 'treatment progress' refers to change in CY-BOCS total score across baseline, treatment week 4 and 8, and end-of-treatment at 16 weeks.

Emotion regulation difficulties Emotion regulation difficulties was assessed by self-report using the 36-item *Difficulties in Emotion Regulation Scale (DERS)* (Gratz & Roemer, 2004). Here, items are rated on a five-point Likert-scale from 1 (*almost never*) to 5 (*almost always*). The DERS yields six subscales encapsulating: (1) non-acceptance of negative emotional responses; (2) difficulties engaging in goal-directed

behavior when experiencing negative emotions; (3) difficulties controlling impulses when experiencing negative emotions; (4) lack of awareness of emotional responses; (5) limited access to emotion regulation strategies perceived as effective; and (6) lack of clarity of emotional responses. Items across subscales are summed to create a total score, DERS-T (range 36 to 180) with higher scores indicating greater difficulties. Validated with adolescents from the age of 11 years, the DERS has been used extensively in clinical and non-clinical studies and has sound psychometric properties (Bardeen et al., 2012; Neumann et al., 2010). In this study, we primarily use self-reported DERS-T from adolescents aged 11 to 17 years (Cronbach's α baseline = .81, end-of-treatment = .79). Additionally, recognizing the recommendations to remove the subscale (4) (lack of awareness) due to weak psychometric properties (Bardeen et al., 2012), in secondary analyses we report all statistical models using a revised total score (DERS-T Revised) of the remaining five subscales. The DERS-T Revised scores are only included for future meta-analyses, and we will thus not conclude upon these results in this manuscript.

Statistical analyses

Characteristics of patients and controls

Demographic and clinical characteristics of the groups were compared using independent-samples t-tests for numerical data (age and IQ) and chi-square test for categorical data (sex).

Analyses on emotion regulation

All outcomes in the emotion regulation analyses are assessed in two ways. First, we combine the FCBT and FPRT groups to examine the relationship between emotion regulation difficulties and psychotherapy, based on evidence that shared elements across interventions (e.g., goal setting and acceptance) may improve emotion regulation and mental health in youth (Helland et al., 2022; Sloan et al., 2017). Second, we compare groups by treatment allocation to directly assess the ERP component proposed as the active mechanism of change for OCD (Foa & Kozak, 1986).

Emotion regulation as outcome of treatment

To examine emotion regulation difficulties as outcome of treatment, we conducted a paired t-test for the combined patient group (*model 1a*) and a linear regression model examining the effect of allocation (*model 1b*). A post hoc paired t-test was conducted to evaluate how emotion regulation difficulties changed in each treatment groups.

Local normative levels of emotion regulation at end-of-treatment

To establish normative levels of emotion regulation on DERS-T, we estimated the upper limit of the 90% reference interval for DERS-T in the controls at end-of-study. To assess if the proportion of patients achieving scores of emotion regulation within normal ranges changed from baseline to end-of-treatment, we conducted a McNemar's mid p-test (*model 2a*) and a logistic regression model to examine the effect of allocation (*model 2b*).

Emotion regulation as moderator on treatment response and progress

To examine baseline emotion regulation difficulties as a moderator of treatment effect, i.e., OCD symptom severity at end-of-treatment, we conducted a linear regression model for all trial patients (*model 3a*) and a linear regression model to assess allocation (*model 3b*). To examine baseline emotion regulation difficulties as a moderator of treatment progress, i.e., OCD symptom change over the course of treatment, we ran two mixed effect linear models, one with time as fixed effect (*model 3c*) and one with allocation as fixed effect (*model 3d*).

Emotion regulation difficulties as mediator of treatment response

To examine change in emotion regulation difficulties as potential mediator of treatment effect, we followed the original 4-steps methods suggested by Baron and Kenny (1986), conducting one model for all trial patients (*model 4a*) and one model for allocation (*model 4b*).

A detailed statistical analysis plan was pre-registered (<https://ssrn.com/abstract=4889194>) and submitted for publication before any analyses were performed (Thoustrup et al., 2025). Alterations from the pre-registered plan are described in **Supplementary material I**. Post hoc sensitivity analyses were performed for each statistical model based on treatment completion, defined as patients completing at least 10 out of 14 therapy sessions. For the pooled analyses of patients, CY-BOCS was treated as a continuous predictor variable. For the analysis of allocation, CY-BOCS was treated as a dichotomous predictor variable (16 to 23 compared to ≤ 24 points), mimicking the stratification of the trial (Olsen et al., 2022). Overall, no imputations were performed, and each analysis only included patients with available data for all relevant model parameters. For the DERS-T, if more than 25% of items were missing on any subscale, the questionnaire from that participant was excluded. If less than 25% was missing, missing values were prorated by averaging the

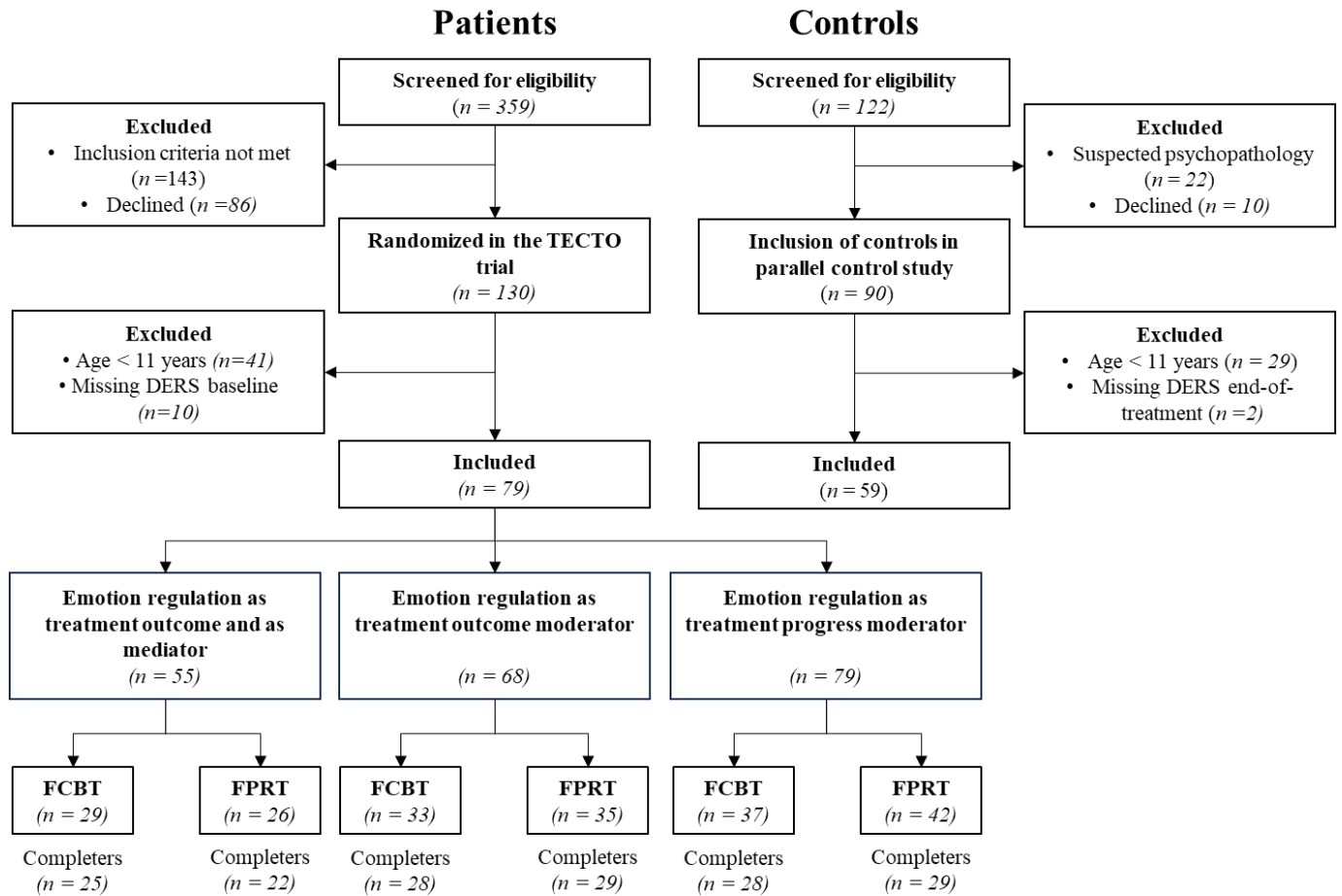
available items and multiplying by the total number of items in the subscale. We assessed statistical assumptions for each model. Normality was checked using histograms and Q-Q plots. No adjustments for multiple comparisons were made, as the study is exploratory. The threshold of significance is $p < .05$. We report estimates, confidence intervals, and effect sizes, considering the risk of false discoveries in our interpretation. All primary analyses were conducted independently by two investigators. Results included in the manuscript and **Supplemental II** are from analyses performed by CT, while results presented in **Supplemental III** are from analyses performed by MHO. Secondary analyses, which included self-reported DERS-T revised, were performed solely by one investigator (MHO). Detailed results of primary and secondary analyses are provided in **Supplementary material II** and **III**. For more comprehensive information on the statistical methods, please see **Supplementary material IV** and the published statistical analysis plan (Thoustrup et al., 2025). Statistical analyses were performed using the R version 4.2.1 (R Core Team, Vienna, Austria) and SPSS version 29 (IBM Corp. Released 2023. IBM SPSS Statistics for Windows, Version 29.0.2.0 Armonk, NY: IBM Corp).

Results

Characteristics of patients and controls

Seventy-nine patients and 59 controls completed the DERS self-reports at baseline (**Figure 1**). The majority reported Danish nationality and no group differences were identified on distribution of sex or age between patients ($n = 79$) and controls ($n = 59$), although they differed on IQ due to higher average IQ score for controls (**Table 1**). Of the 79 patients, 37 were randomized to FCBT and 42 to FPRT. Treatment groups did not differ in terms of sex, age, or IQ. Mean CY-BOCS scores at inclusion reflected moderate to severe OCD, with no difference between treatment groups at baseline. A similar proportion of patients in both treatment groups were diagnosed with at least one comorbid disorder. Finally, examining associations between age and DERS-T scores, neither the age of patients ($R^2 = 0.00$; 95% CI -0.22 to 0.22; $p = 0.986$) nor controls ($R^2 = 0.03$; 95% CI -0.42 to 0.08; $p = 0.174$) were correlated in this study.

Figure 1. Participant flowchart



Note. TECTO = Treatment Effects of Cognitive-behavioral Therapy for Obsessive-Compulsive Disorder; DERS = Difficulties in Emotion Regulation Scale; Emotion regulation as outcome and mediator represents models using DERS-T at baseline and end-of-treatment (Models 1a, 1b, 2a, 2b, 4a, 4b); Emotion regulation as treatment outcome moderator represents models using DERS-T at baseline and CY-BOCS at baseline and CY-BOCS end-of-treatment (Models 3a and 3b); Emotion regulation as treatment progress moderator represent models using DERS-T at baseline (3c and 3d). FCBT = family-based cognitive behavioral therapy; FPRT = Family-based psychoeducation and relaxation training; Treatment completion refers to TECTO patients completing a minimum of 10 out of 14 psychotherapy sessions (FCBT or FPRT).

Table 1. Demographic and clinical characteristics

Baseline characteristics	OCD (n = 79)		Controls (n = 59)	
	FCBT	FPRT	<i>p^a</i>	<i>p^b</i>
Number of patients	37	42		
Sex			0.370	0.491
Female (%)	21 (56.80)	19 (45.20)		34 (57.60)
Male (%)	16 (43.20)	23 (54.80)		25 (42.40)
Mean age in years (<i>SD</i>)	14.42 (1.96)	14.41 (1.99)	0.974	14.51 (2.02)
Mean IQ ¹ (<i>SD</i>)	98 (12.86)	97.98 (13.24)	0.994	105 (14.00)
Nationality				
Danish (%)	29 (85.30)	36 (97.30)		42 (72.10)
Other (%)	5 (14.70)	1 (2.70)		3 (4.90)
Missing (%)	3 (8.10)	5 (13.50)		14 (23.70)
Mean CY-BOCS ² baseline total score (<i>SD</i>)	25.08 (4.56)	25.17 (4.78)	0.936	
Co-occurring psychiatric disorders (%)				
Asperger's Syndrome (F84.5)	2 (5.40)	7 (16.70)		
Anxiety disorders ³ (F40.0, 40.1, 40.2, 41.1, 93.8)	5 (13.50)	8 (19.00)		
Adjustment disorder ⁵ (F43.23)	3 (8.10)	5 (11.90)		
Hyperkinetic disorders (F90, 90.1, 98.8)	4 (10.80)	5 (11.90)		
Tic disorders (F95)	4 (10.80)	5 (11.90)		
Other ⁶	7 (18.90)	4 (9.50)		
Total with at least one co-occurring disorder (%)	20 (54.10)	22 (52.40)		

Note. Ethnicity was not assessed as this is not standard practice in the Danish health care system ^a Group differences between FCBT and FPRT; ^b Group differences between patients and controls; ¹ IQ measured as the General Ability Index from the Wechsler Scales; ² Children's Yale-Brown Obsessive Compulsive Scale (range 0-40); ³ Anxiety disorders 40.0 Agoraphobia, 40.1 Social phobia, 40.2 Specific (isolated) phobias, 41.1 Generalized anxiety disorder, 93.8 Other childhood emotional disorders; ⁵ Adjustment disorder with mixed anxiety and depressed mood (F43.23); ⁶ Other: F30-F39 Mood [affective] disorders (FCBT *n* = 0, FPRT *n* = 1), F50-59 Behavioral syndrome associated with physiological disturbances and physical factors (FCBT *n* = 3, FPRT *n* = 0), F60-69 Disorders of adult personality and behavior (FCBT *n* = 1, FPRT *n* = 0), F80-89 (FCBT *n* = 1, FPRT *n* = 2), F91-98 Behavioral and emotional disorders with onset usually occurring in childhood and adolescence (FCBT *n* = 3, FPRT *n* = 1)

Table 2. OCD symptom severity and emotion regulation difficulties severity by group

	FCBT		FPRT		Controls
	CY-BOCS	DERS-T	CY-BOCS	DERS-T	DERS-T
Baseline	25.08 (4.56)	87.73 (24.84)	25.17 (4.78)	83.51 (18.63)	67.61 (12.24)
Week 4	22.88 (5.17)		23.80 (5.77)		
Week 8	18.94 (6.40)		22.72 (4.84)		
End-of-treatment	15.15 (7.27)	70.52 (18.67)	19.08 (8.39)	80.23 (18.54)	67.17 (14.24)

Note. Mean values are presented with standard deviation in parentheses. Higher scores indicate more emotion regulation difficulties and OCD symptom severity; DERS-T = total score of Difficulties in Emotion Regulation Scale (range 36-180); CY-BOCS = Children's Yale-Brown Obsessive Compulsive Scale (range 0-40). FCBT = family-based cognitive behavioral therapy; FPRT = Family-based psychoeducation and relaxation training; Number of patients with valid data: CY-BOCS baseline, FCBT $n = 37$, FPRT $n = 42$; CY-BOCS week 4, FCBT $n = 33$, FPRT $n = 41$; CY-BOCS week 8, FCBT $n = 34$, FPRT $n = 40$; CY-BOCS End-of-treatment, FCBT $n = 33$, FPRT $n = 36$; DERS-T baseline, FCBT $n = 37$, FPRT $n = 42$, controls $n = 59$; DERS-T end-of-treatment, FCBT $n = 29$, FPRT $n = 26$, controls $n = 59$. For CY-BOCS and DERS scores on completers vs. non-completers in the FCBT and FPRT group see **Supplementary Material II**.

Emotion regulation as outcome of treatment

For all patients (*model 1a*, $n = 55$), mean DERS-T changed from 85.66 (SD: 22.66) at baseline to 75.11 (SD: 19.07) at end-of-treatment, with a mean change of 10.55 (95% CI 4.95 to 16.15, $p < .001$). Furthermore, DERS-T at end-of-treatment differed between treatment groups (*model 1b*, $n = 55$) when accounting for baseline DERS and CY-BOCS, (mean difference: -11.56, 95% CI -20.23 to -2.89, $p < 0.010$), as patients receiving FCBT reported less emotion regulation difficulties ($n = 29$, mean = 70.52; SD: 18.67) than those receiving FPRT ($n = 26$, mean = 80.23; SD: 18.54) (**Table 2**). Post hoc paired t-tests demonstrated that patients receiving FCBT reported significantly less ER difficulties after intervention (95% CI -25.63 to -8.19, $p < .001$), while those receiving FPRT did not (95% CI -9.72 to 2.79, $p = .265$). Sensitivity analyses for treatment completers ($n = 47$) showed comparable results (see **Supplementary II**).

Local normative levels of emotion regulation at end-of-treatment

To establish a local reference threshold for normative levels of emotion regulation, we used DERS-T scores from the control group. First, we conducted a paired t-test to evaluate the stability of emotion regulation in the controls (DERS-T baseline to end-of-study mean difference: -1.29, 95% CI -3.98 to 1.40, $p = 0.342$). Then, we estimated the upper limit of the 90% reference interval for DERS-T in controls at end-of-study, which was 90.59 (for details, see **Supplementary Material II**). Thus, scores on DERS-T above 90.59 were defined as abnormal emotion regulation.

For all patients who reported DERS-T at baseline and end-of-treatment (*model 2a*, $n = 55$), we found a decrease in the proportion reporting abnormal scores from 20 (36.4%) at baseline to 12 (21.8%) at end-of-

treatment ($p = .04$). The likelihood of reporting DERS scores indicative of normal emotion regulation at end-of-treatment was not different between treatment groups (*model 2b*, $n = 55$), (odds ratio (OR): 0.378, 95% CI: .075 to 1.911, $p = 0.239$). Sensitivity analyses on treatment completers on model 2a suggested that the proportion of all patients reporting emotion dysregulation did not statistically change from baseline to end-of-treatment ($p < 0.065$) (**Supplementary Material II**).

Emotion regulation as moderator on treatment response

For all patients (*model 3a*, $n = 68$), baseline DERS-T did not moderate treatment response ($b = 0.39$, 95% CI: -0.11 to 0.89, $p = 0.123$). Additionally, DERS-T by treatment group (*model 3b*, $n = 68$) did not moderate treatment response ($b = -0.15$, 95% CI: -0.32 to 0.01, $p = 0.062$). Sensitivity analysis on treatment completers showed similar results (**Supplementary Material II**).

Emotion regulation as moderator on treatment progress

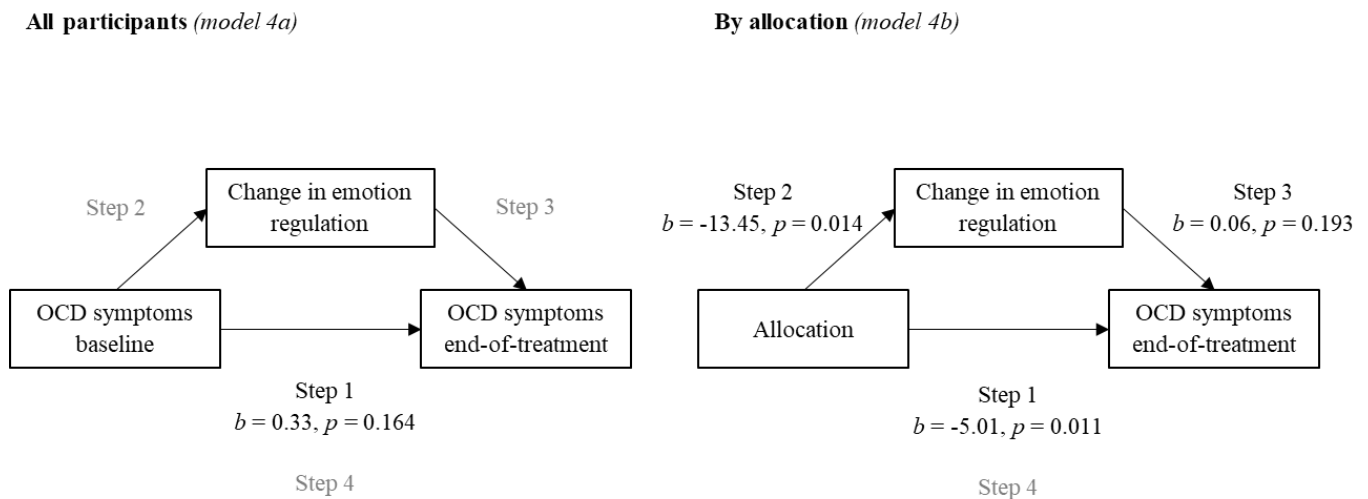
Baseline DERS-T did not moderate treatment progress, i.e., symptom change during treatment for all patients (*model 3c*, $n = 79$, ($b = -0.02$, 95% CI: -0.05 to 0.01, $p = 0.112$). Additionally, DERS-T by treatment group (*model 3d*, $n = 79$) did not significantly moderate treatment progress, as indicated by a confidence interval that includes zero ($b = -0.06$, 95% CI: -0.12 to 0.00, $p = 0.049$). Sensitivity analysis on treatment completers showed similar results (**Supplementary Material II**).

Emotion regulation difficulties as mediator of treatment response

In examining whether changes in emotion regulation difficulties mediated the treatment effect, we followed the planned four-step method. The mediation model for all patients (*model 4a*, $n = 55$) showed that baseline CY-BOCS (Step 1) did not predict end-of-treatment CY-BOCS ($b = 0.33$, 95% CI: -0.14 to 0.80, $p = 0.164$, see **Figure 3**). Consistent with the recommendations from Baron and Kenny (1986), the subsequent mediation steps are not reported here (for Step 2-4 and indirect effect, see **Supplementary material II**). For the mediation model by treatment allocation (*Model 4b*, $n = 55$), the total effect (Step 1) of allocation on CY-BOCS at end-of-treatment was significant ($b = -5.01$, 95% CI: -1.17 to -8.85, $p = 0.011$, see **Figure 3**). Furthermore, treatment allocation predicted change in DERS-T ($b = -13.45$, 95% CI: -24.16 to -2.74, $p = 0.014$). However, the effect of change in DERS-T on CY-BOCS at end-of-treatment when accounting for allocation (Step 3) was not significant ($b = 0.06$, 95% CI: -0.03 to 0.16, $p = 0.193$). Therefore, the subsequent mediation steps are not reported here (for Step 4 and indirect effect, see **Supplementary**

material II). Sensitivity analysis including treatment completers for all patients showed no significance in Step 2-4 and in the analysis by treatment group, Step 1 was non-significant. (**Supplementary Material II**).

Figure 3. Mediation models of the indirect effect of emotion regulation change on treatment response



Note. OCD symptoms baseline and end-of-treatment measured as mean total score on CY-BOCS (Children's Yale-Brown Obsessive Compulsive Scale (range 0-40)); Change in emotion regulation = T2-T1 for mean DERS-T (Difficulties in Emotion Regulation Scale total score (range 36-180)); Allocation = FCBT (family-based cognitive behavioral therapy) = 1; FPRT (Family-based psychoeducation and relaxation training) = 0; Number of patients, FCBT $n = 29$, FPRT $n = 26$.

Discussion

We examined the role of emotion regulation as outcome, moderator, and mediator in two intervention types for pediatric OCD to explore whether emotion regulation is implicated in treatment through shared elements across interventions or is specifically linked to ERP, the proposed active mechanism of change for OCD. Three main findings were identified; (1) FCBT led to greater improvements in emotion regulation compared to FCBT; (2) baseline emotion regulation difficulties did not moderate treatment response nor progress; and (3) changes in emotion regulation difficulties did not mediate treatment response. Furthermore, using a local reference threshold for normative emotion regulation on the DERS, the proportion of patients reporting scores indicative of abnormal emotion regulation decreased from 36.4% at baseline to 21.8% at end-of-treatment, regardless of treatment group. Sensitivity analyses on treatment completers yielded results comparable to the main analyses, except that the proportion of patients with abnormal DERS scores did not differ statistically between baseline and end-of-treatment. However, the percentage of patients transitioning from abnormal to normal scores was comparable (60% for all patients, 56.25% for treatment completers).

Emotion regulation difficulties as outcome of pediatric OCD treatments

Our finding that emotion regulation improves for adolescents with OCD following FCBT corroborates previous research suggesting CBT-related improvements of emotional dysregulation (Krebs et al., 2013; McGuire et al., 2013). Importantly, our study is the first to suggest that improved emotion regulation following psychotherapy may be specific to FCBT when compared to treatments using manualized relaxation techniques – here defined as FPRT. This suggests that while FCBT and FPRT may to some extent be effective in reducing OCD symptoms (Piacentini et al., 2011), adolescents with emotion regulation difficulties may benefit more from FCBT. These findings are likely due to the structured cognitive and behavioral techniques used in FCBT, such as exposure and response prevention, which directly target maladaptive OCD beliefs and behaviors. These techniques may have a stronger emotional impact compared to the primarily physiological focus of the relaxation techniques in FPRT. Additionally, FCBT may reinforce this emotional impact by requiring adolescents to engage in more proactive behavior and self-regulation during treatment.

In the absence of established norms for the DERS, we used scores from our control group to estimate local a reference level for normative emotion regulation (Thoustrup & Olsen, 2024). At baseline, 36.4% of the adolescents with OCD exhibited DERS scores indicative of abnormal emotion regulation. This finding aligns with previous studies, reporting dysregulation in 20% to 38.5% of patients with similar age ranges and OCD symptom severity (Krebs et al., 2013, $n = 387$; McGuire et al., 2013, $n = 144$). However, it should be noted that emotion dysregulation was conceptualized and measured differently in these studies; Krebs et al. (2013) used ratings of ‘certainly true’ for temper outburst item from the Strengths and Difficulties Questionnaire, while McGuire et al. (2013) used the mean total score from the Child Behavior Checklist-Dysregulation Profile.

While emotion regulation in the control group remained stable over 16 weeks (mimicking the duration of psychotherapy), the percentage of adolescents with OCD who reported emotion regulation within the abnormal range decreased from 36.4% at baseline to 21.8% at end-of-treatment. Unlike our findings of improved emotion regulation abilities in the FCBT group, as reflected in the continuous measure of mean DERS-T change, there were no significant differences between treatment groups in the proportion of patients achieving normalization post-treatment when using the categorical outcome. This null finding likely reflects the reduced statistical power of categorical rather than continuous analyses. However, a larger sample size might also reveal differences in categorical outcomes.

Baseline levels of emotion regulation difficulties as moderator as pediatric OCD treatments

Emotion regulation difficulties did not moderate treatment response or progress, in contrast to McNamara et al. (2014), who reported that poorer baseline emotional control predicted slower and less substantial reduction in OCD symptoms after CBT. Several factors may explain these differing results: (1) differences in intervention strategies (we used family-based CBT, whereas McNamara et al. used non-family CBT with or without pharmacological augmentation), (2) variations in participant characteristics (28.6% of McNamara et al.'s sample had comorbid depression, compared to 1.3% in ours), and (3) differences in how emotion regulation was conceptualized. In McNamara et al. (2014) emotion regulation focused largely on behavioral dysregulation and emotional reactivity, while the conceptualization used in our study emphasize cognitive as well as behavioral difficulties (Gratz & Roemer, 2004). Future studies using the DERS may benefit from examining the individual subscales rather than the total score, as specific aspects of emotion regulation may influence treatment progress and response in ways that are masked within the overall score. Supporting this, Bredemeier et al. (2022) found that lower baseline emotional awareness, a subscale from the DERS, was associated with better self-reported treatment outcome after CBT for adults with OCD. These reflections highlight the importance of conceptual foundations questionnaires design, as different measures capture distinct aspects of emotional functioning (Martínez-Priego et al., 2024). Understanding which dimensions of emotion regulation are assessed is essential in interpreting treatment variability and refining interventions to target the most relevant emotional process.

Change in emotion regulation difficulties as mediator of pediatric OCD treatments

Changes in emotion regulation did not mediate treatment response. This result was somewhat unexpected given that well-established theoretical models of OCD treatment, such as the inhibitory learning model (Craske et al., 2014) and emotional processing theory (Foa & McLean, 2016), suggest improvements in abilities related to emotion regulation to play a key role in treatment response, such as tolerating emotional distress without resorting to maladaptive behaviors (e.g. compulsions), and reducing emotional reactivity through confronting feared situations. To our knowledge, only one previous study has examined emotion regulation difficulties as a mediator of treatment effects for OCD in a transdiagnostic sample of 274 adults, including 94 with a primary OCD diagnosis (Asnaani et al., 2020). Unlike our findings on OCD symptomatology, Asnaani et al. (2020) reported that emotion regulation difficulties, measured via the DERS, mediated changes in anxiety symptoms during exposure-based treatment. However, both emotion regulation and anxiety symptoms were assessed using self-reports, potentially introducing shared method variance (Podsakoff et al., 2024). This may have inflated the observed mediation effect. Additionally, the small effect size ($\beta = -0.06$) reported in the study is likely beyond our statistical power to detect.

As a final reflection, the broad conceptualization of emotion regulation used in our study is worth considering. While the DERS primarily addresses regulation of common emotional responses, such as feeling upset and frustrated, improving regulation of such emotions may not directly impact treatment effectiveness for OCD. Consequently, future clinical studies should explore how regulation of emotions more closely tied to OCD impact treatment outcomes. For example, preliminary evidence suggests that changes in disgust proneness are associated with reduction in OCD symptom severity following CBT (Knowles et al., 2016). In line with this, regulation of emotions such as disgust, fear, shame, anger, and feelings of incompleteness could be of particular interest (Barcaccia et al., 2022; Cervin et al., 2020; Laving et al., 2023). Finally, future work may also improve from examining to what extent emotion regulation difficulties interact with treatment outcomes across different symptom dimensions. Such lines of investigations could provide deeper insight into how emotion regulation difficulties affect treatment effectiveness, potentially guiding more targeted and effective interventions.

Strengths and limitations

The present study has numerous strengths. First, this study is the first to examine whether emotion regulation difficulties in pediatric OCD relate to treatment through shared treatment elements or uniquely to the ERP component. Second, it is also the first to explore emotion regulation as treatment outcome, moderator, and mediator in this context. Although potentially underpowered to detect significant moderation and mediation effects, including these analyses highlights the complexity of treatment mechanisms, setting the foundation for future studies with larger samples. Third, sensitivity analyses on treatment completion were conducted to account for variability in treatment engagement, adding robustness and generalizability to the findings. Fourth, estimating a local reference threshold for normative emotion regulation from the control group provided context for interpreting the emotion regulation difficulties faced by the clinical group relative to typically developing peers, aiding in the evaluation of the severity and nature of these challenges in OCD. Finally, preregistering the statistical analyses and having two independent investigators perform the analyses using different statistical software strengthened the rigor and reliability of the research. Some limitations should be considered when interpreting the findings. First, while it is accurate to describe FPRT as a psychotherapy that includes relaxation techniques, PRT is not equivalent to all interventions using these methods, as FPRT is manualized and involves family participation. Second, we acknowledge that the control group used to calculate a local reference threshold for normative emotion regulation in the DERS consists of highly selected adolescents without any mental health conditions, which may limit representativeness. A more heterogeneous sample might yield higher reference intervals, potentially affecting the classification of dysregulation in OCD (Thoustrup & Olsen, 2024). Finally, the study relied on self-reported emotion regulation, despite emotion regulation being a complex process with behavioral, physiological, and

interpersonal dimensions. Future longitudinal studies could provide valuable insights into how emotion regulation impacts treatment outcomes in pediatric OCD by incorporating multi-informant and multi-modal assessments, including clinical interviews, behavioral observations, and physiological measures.

Conclusion

The present study makes a significant contribution to the limited literature on the role of emotion regulation difficulties in pediatric OCD treatment in two ways. First, it is the first to approach emotion regulation difficulties from a multidimensional perspective, rather than focusing solely on deficits in control or behavioral dysregulation. This broader conceptualization allows for a more comprehensive examination of emotional functioning, which may be more relevant to children with OCD, as it encompasses various emotional challenges beyond heightened emotional reactivity. Second, the study defined interventions as both evidence-based ERP and clinically common relaxation techniques, enabling an exploration of how emotion regulation may be implicated in treatment through shared therapeutic elements or specifically through ERP, the active mechanism in OCD treatment. While improvements in emotion regulation were observed in children receiving FCBT but not FRPT, emotion regulation was not found to moderate or mediate treatment outcomes. Future longitudinal research should further investigate the impact of each emotion regulation domain to clarify the role of emotion regulation in pediatric OCD treatment.

Data transparency

After publication of all results from the TECTO trial, we plan to make a depersonalized data set publicly available on the EU ZENODO database.

Conflict of interest

Valdemar Funch Uhre is currently employed by Novo Nordisk A/S. The authors declare no other conflicts of interests.

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Supplementary material I - Implications of emotion regulation difficulties for psychotherapy in pediatric OCD

Deviations for pre-registered analysis plan

- We used two independent softwares (R and SPSS) for the primary analyses on DERS-T. For the secondary analyses DERS-T Revised, we used the latest available stable version of R (R Core Team, Vienna, Austria).
- We decided not to report the parent-reported DERS-T, due to poor test-retest effect on parent-reported DERS-T in the control group (mean difference = 7.2, 95% CI: 5.1 to 9.3, $p < .001$). This may be due to poor reliability and thus we chose to remove the parent reports from all analyses.
- Coding of treatment allocation was changed, such that FCBT = 1 and FPRT = 2
- For clarity and continuity, we renamed the following models:
 - Model 3c → Model 3b
 - Model 3b → Model 3c
- Model 4a step 4 path c' has been run with CY-BOCS end-of-treatment as outcome, and CY-BOCS baseline and DERS change as fixed effects.
- Model 4b step 4 path c' has been run with CY-BOCS end-of-treatment as outcome, and allocation and DERS change as fixed effects.
- Model 4b – CY-BOCS was removed as covariate from analyses.
- We decided to run the following sensitivity analyses:
 - For all models: Treatment completers as defined by attending at least 10 of 14 sessions of psychotherapy.
 - For model 1b: To examine how the differences in DERS-T at end-of-treatment by allocation translate into each of the 6 subscales, we ran a paired t-test for each subscale by allocation.
 - For model 3b: We examined the correlation between DERS-T baseline and CY-BOCS baseline and end-of-treatment by treatment group.
 - For model 4a: To examine if the insignificant Total effect was due to limited statistical power, we reran the model allowing for all participants with valid data on CY-BOCS at baseline and end-of-treatment, thereby increasing our sample size from $n = 55$ to $n = 78$.

Violation of statistical assumptions

- Model 1a:

- 1) Outliers: One outlier at baseline. It was retained in analyses.
- 2) Normality: DERS-T scores at baseline and end-of-treatment were not normally distributed as assessed by Shapiro-Wilk's test ($p < .05$) and visual inspection of histograms and Normal Q-Q plots. Non-normality does not affect Type 1 error rate substantially and the one-paired t-test is considered robust.
- Model 1b: No violations.
- Model 2a: No violations.
- Model 2b: No violations.
- Model 3a:

Multicollinearity: As expected there is some association between the covariates as expected with psychological measurements (all VIF's > 10), see table below.

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-36,626	23,519		-1,557	,124	-83,597	10,345		
	WQ_CYBOCS	2,133	,950	1,178	2,245	,028	,235	4,031	,049	20,574
	WQ_Child_DERS_Total_sum	,447	,254	1,243	1,764	,082	-,059	,954	,027	37,098
	Int_OCDBaseXERbase	-,017	,010	-1,798	-1,753	,084	-,037	,002	,013	78,666

^a Dependent Variable: W16_CYBOCS

- Model 3b: No violations.
- Model 3c: Residuals for fixed effects were not normally distributed by Shapiro-Wilk's test ($p < .05$) and visual inspection of histograms and Normal Q-Q plots. Furthermore, a significant Shapiro-Wilk's test suggested that the slope for random effects were not normally distributed, which may be due to one single outlier on the QQ plot. Importantly, research suggests mixed-models to be robust even if distributional assumptions are violated (1).
- Model 3d: Residuals for fixed effect were not normally distributed by Shapiro-Wilk's test ($p < .05$). Visual examination of QQ plot and histogram suggested a slight left tail.
- Model 4a: DERS change was not normally distributed by Shapiro-Wilk's test ($p < .05$) and visual inspection of histograms and Normal Q-Q plots.
- Model 4b: No violations.

Reference

1. Schielzeth H, Dingemanse NJ, Nakagawa S, Westneat DF, Alaguela H, Teplitsky C, et al. Robustness of linear mixed-effects models to violations of distributional assumptions. *Methods Ecol Evol.* 2020;11(9):1141–52.

Supplementary material II - Implications of emotion regulation difficulties for psychotherapy in pediatric OCD

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1. Emotion regulation as outcome Change in emotion dysregulation from baseline to end-of-treatment

Model 1a – all participants

For all participants (*model 1a*, $n = 55$), mean DERS-T changed from 85.66 (SD: 22.66) at baseline to 75.11 (SD: 19.07) at end-of-treatment, with a mean change of 10.55 (95% CI 4.95 to 16.15, $p < .001$).

Completers – model 1a

For completers ($n = 47$), mean DERS-T changed from 83.43 (SD: 19.93) at baseline to 72.43 (SD: 17.47) at end-of-treatment, with a mean change of 10.99 (95% CI 5.43 to 16.56, $p < .001$).

Model 1b – by allocation

Linear regression results for DERS-T end-of-treatment by allocation

DERS-T	<i>B</i>	<u>95% CI for <i>B</i></u>		<i>SE B</i>	β	<i>p</i>	R^2	ΔR^2
End-of-treatment		<i>LL</i>	<i>UL</i>					
Model							.36	.32
Constant	42.89	23.39	62.39	9.71		<0.001		
Allocation ¹	-11.56	-20.22	-2.89	4.31	-.30	0.010		
DERS-T ³ baseline	.46	.26	.66	.10	.55	<0.001		
CY-BOCS ²	-.89	-9.96	8.17	4.51	-.02	0.844		

Note. Model = “Enter” method in SPSS Statistics; ¹ Allocation: FCBT versus FPRT; ²Children’s Yale-Brown Obsessive-Compulsive Scale (16 to 23 vs. ≤ 24 points); ³ Difficulties in Emotion Regulation Scale total score; *B* = unstandardized regression coefficient; CI = confidence interval; LL = lower limit; UL = upper limit; *SE B* = standard error of the coefficient; β = standardized coefficient; R^2 = coefficient of determination; ΔR^2 = adjusted R^2 ; **

Completers - model 1b

Linear regression results for DERS-T end-of-treatment by allocation

DERS-T	<i>B</i>	<u>95% CI for <i>B</i></u>		<i>SE B</i>	β	<i>p</i>	R^2	ΔR^2
End-of-treatment		<i>LL</i>	<i>UL</i>					
Model							0.33	0.29
Constant	42.10	20.49	63.71	10.72		<0.001		
Allocation ¹	-10.42	-19.15	-1.68	4.33	-0.30	0.021		
DERS-T ³ baseline	0.448	0.22	0.67	0.11	0.51	<0.001		
CY-BOCS ²	-0.970	-9.88	7.94	4.42	-0.03	0.827		

Note. Model = “Enter” method in SPSS Statistics; ¹ Allocation: FCBT versus FPRT; ²Children’s Yale-Brown Obsessive-Compulsive Scale (16 to 23 vs. ≤ 24 points); ³ Difficulties in Emotion Regulation Scale total score; *B* = unstandardized regression coefficient; CI = confidence interval; LL = lower limit; UL = upper limit; *SE B* = standard error of the coefficient; β = standardized coefficient; R^2 = coefficient of determination; ΔR^2 = adjusted R^2 ;

Post hoc – paired t-test

Patients receiving FCBT reported significantly less ER difficulties on the DERS from baseline to end-of-treatment, while the patients in the FPRT group did not.

	Baseline	End-of-treatment	95% CI		<i>p</i>
	M (SD)	M (SD)	LL	UL	
FCBT	87.43 (26.77)	70.52 (18.67)	-25.63	-8.19	< .001
FPRT	83.70 (17.32)	80.23 (18.54)	-9.72	2.79	.265

Note. Mean and standard deviations for DERS-total.

Completers - Post hoc

	Baseline	End-of-treatment	95% CI		<i>p</i>
	M (SD)	M (SD)	LL	UL	
FCBT	84.20 (22.42)	67.93 (16.75)	-24.57	-7.97	< .001
FPRT	82.55 (17.16)	77.55 (17.21)	-12.09	2.08	.157

Note. Mean and standard deviations for DERS-total.

2. Normative levels of emotion regulation at end-of-treatment

Model 5. Stability of emotion regulation over time in healthy controls

A paired samples t-test ($n = 57$) examined the stability of emotion regulation in the healthy control group from baseline to end-of-study. DERS-T scores showed no significant change from baseline ($M = 68.12$, $SD = 12.13$) to end-of-study ($M = 66.84$, $SD = 14.25$), with a mean difference of -1.29 (95% CI -3.98 to 1.40), $p = .34$.

Estimating the 90% reference interval for healthy controls, DERS-T end of study

Observations = 59; Mean = 67.17; $SD = 14.24$; Margin of error = $1.645 * 14.24 = 23.42$

Lower limit (mean – margin of error) = 43.75

Upper limit (mean + margin of error) = 90.59

Model 2a - all participants

The upper limit of the 90% reference interval for DERS-T for healthy controls at end of study was estimated to 90.59 (see Supplementary material). Thus, participants with scores on DERS-T above 90.59 were labeled abnormal in their emotion regulation. Of the 55 participants reporting DERS-T at both baseline and end-of-treatment, 20 (36.4%) were labeled abnormal at baseline and 12 (21.8%) were labeled abnormal at end-of-treatment (Table x). The McNemar's test determined that the difference in the proportion of emotionally dysregulated participants at baseline and end-of-treatment was statistically significant, $p = .04$.

Emotion regulation ability status at baseline and end-of-treatment

	Baseline	End-of-treatment
Abnormal	20 (36.4%)	12 (21.8%)
Normal	35 (63.6%)	43 (78.2%)
Total	55 (100%)	55 (100%)

Note. Normal refers to DERS-T scores below 90.59. Number of participants with scores on DERS-T labeled normal and abnormal.

Completers – model 2a

The upper limit of the 90% reference interval for DERS-T for healthy controls at end of study was estimated to 90.59. Thus, participants with scores on DERS-T above 90.59 were labeled abnormal in their emotion

regulation. Of the 47 treatment completers reporting DERS-T at both baseline and end-of-treatment, 16 (34%) were labeled abnormal at baseline and 9 (19.1%) were labeled abnormal at end-of-treatment. The McNemar's test determined that the difference in the proportion of emotionally dysregulated participants at baseline and end-of-treatment was not statistically significant, $p = .065$.

Emotion regulation ability status at baseline and end-of-treatment (completers)

	Baseline	End-of-treatment
Abnormal	16 (34%)	9 (19.1%)
Normal	31 (65.9%)	38 (80.9%)
Total	47 (100%)	47 (100%)

Note. Normal refers to DERS-T scores below 90.59. Number of participants with scores on DERS-T labeled normal and abnormal.

Model 2b - by allocation

A logistic regression model was used to assess differences in normative proportion changes between treatment groups. Dichotomized DERS-T scores end-of-treatment (normal vs abnormal) was used as outcome, and treatment type, DERS-T baseline and CY-BOCS baseline (16 to 23 vs. ≤ 24 points) were fixed effects. The model was statistically significant, $\chi^2(3) = 13.88$, $p < .003$, explaining 34% of the variance in emotion regulation outcomes (Nagelkerke R^2) and correctly classifying 80% of participants. Sensitivity was 58%, specificity 90%, with a positive predictive value of 84.8% and a negative predictive value of 55.6%. Baseline emotion regulation was the only significant predictor with greater difficulties reducing the likelihood of normal emotion regulation at end-of-treatment.

Logistic regression results on the likelihood of normal DERS-T end-of-treatment

Normal/Abnormal End-of-treatment	<i>B</i>	<i>SE B</i>	<i>OR</i>	<u>95% CI for OR</u>		<i>p</i>	Nagelkerke R^2
				<i>LL</i>	<i>UL</i>		
Model							0.34
Constant	6.98	2.07				<0.001	
Allocation ¹	-.973	.83	.38	.08	1.91	0.239	
DERS-T baseline ²	-.05*	.02	.95	.92	.99	0.012	
CY-BOCS ³	-1.17	.90	.31	.05	1.81	0.312	

Note. Model = “Enter” method in SPSS Statistics; ¹ Allocation: FCBT versus FPRT; ²Children’s Yale-Brown Obsessive-Compulsive Scale (16 to 23 vs. ≤ 24 points); ³ Difficulties in Emotion Regulation Scale total score; *B* = unstandardized regression coefficient; *SE B* = standard error of the coefficient; 95% CI = confidence interval; LL = lower limit; UL = upper limit; $R^2 = .73$ (Hosmer & Lemeshow) .22 (Cox and Snell) .34 (Nagelkerke); * $p < .05$, *** $p < .001$

Emotion regulation ability status at end-of-treatment by treatment group

	FCBT	FPRT
Normal	24 (82.8%)	19 (73.1%)
Abnormal	5 (17.3%)	7 (26.9%)
Total	29 (100%)	26 (100%)

Note. Normal refers to DERS-T scores below 90.59. Number of participants with scores on DERS-T labeled normal and abnormal.

Completers - model 2b

Logistic regression results on the likelihood of normal DERS-T end-of-treatment

Normal/Abnormal End-of-treatment	<i>B</i>	<i>SE B</i>	<i>OR</i>	<u>95% CI for OR</u>		<i>p</i>	Nagelkerke R^2
				<i>LL</i>	<i>UL</i>		
Model							0.26
Constant	5.99	2.15		3.83	29.23	0.005	
Allocation ¹	.595	.85	1.81	-1.58	4.16	0.483	
DERS-T baseline ²	-.05*	.02	.95	-0.15	-0.02	0.039	
CY-BOCS ³	-1.19	.91	.30	-20.88	0.72	0.192	

²Children’s Yale-Brown Obsessive-Compulsive Scale (16 to 23 vs. ≤ 24 points)

Emotion regulation ability status at end-of-treatment for treatment completers by treatment group

	FCBT	FPRT
Normal	21 (84%)	17 (77,3%)
Abnormal	4 (16%)	5 (22.7%)
Total	25 (100%)	22 (100%)

Note. Normal refers to DERS-T scores below 90.59. Number of participants with scores on DERS-T labeled normal and abnormal.

3. Emotion regulation as moderator on treatment outcome and progress

Model 3a - all participants

A moderation analysis examined whether OCD symptom severity at end-of-treatment depended on the level of baseline emotion dysregulation. The interaction term was non-significant ($p = .126$), indicating that baseline emotion dysregulation did not moderate the relationship between OCD symptoms at baseline and end-of-treatment.

CY-BOCS	<i>B</i>	<u>95% CI for <i>B</i></u>		<i>SE B</i>	β	<i>p</i>	R^2	ΔR^2
End-of-treatment								
		<i>LL</i>	<i>UL</i>					
Model							0.11	0.06
Constant	-30.18	-77.16	16.79	23.52	-1.28	0.204		
CY-BOCS baseline	1.89	-0.01	3.78	0.95	1.99	0.051		
DERS-T baseline	0.39	-0.11	0.89	0.25	1.56	0.123		
CYBOCS*DERS	-0.02	-0.04	0.00	0.01	-1.55	0.126		

Note. CY-BOCS = Children's Yale-Brown Obsessive-Compulsive Scale; DERS = Difficulties in Emotion Regulation Scale total score.

Completers - model 3a

CY-BOCS	<i>B</i>	<u>95% CI for <i>B</i></u>		<i>SE B</i>	β	<i>p</i>	R^2	ΔR^2
End-of-treatment								
		<i>LL</i>	<i>UL</i>					
Model							0.10	.05
Constant	-5.20	-51.69	41.28	23.18		0.823		
CY-BOCS baseline	0.63	-1.28	2.54	0.95	0.41	0.510		
DERS-T baseline	0.18	-0.32	0.67	0.25	0.53	0.481		
CYBOCS*DERS	-0.00	-0.02	0.02	0.01	-0.46	0.676		

Note. CY-BOCS = Children's Yale-Brown Obsessive-Compulsive Scale; DERS = Difficulties in Emotion Regulation Scale total score.

Model 3b - by allocation

A moderation analysis examined whether baseline DERS-T moderated the effect of treatment type (FCBT vs. FPRT) on end-of-treatment CY-BOCS, adjusting for baseline CY-BOCS. The interaction term was not significant ($p = .062$).

CY-BOCS	<i>B</i>	<u>95% <i>CI</i> for <i>B</i></u>		<i>SE B</i>	β	<i>p</i>	R^2	ΔR^2
End-of-treatment		<i>LL</i>	<i>UL</i>					
Model							0.19	0.14
Constant	3.71	-7.95	15.37	5.83		0.527		
Allocation	9.22	-5.21	23.64	7.22	0.59	0.206		
CY-BOCS baseline	3.20	-0.67	7.07	1.94	0.20	0.104		
DERS-T baseline	0.13	-0.01	0.26	0.07	0.36	0.064		
Allocation*DERS	-0.16	-0.32	0.01	0.08	-0.94	0.062		

Note. Allocation: FCBT = 1 versus FPRT = 0; Difficulties in Emotion Regulation Scale total score;

³Children's Yale-Brown Obsessive-Compulsive Scale (16 to 23 vs. ≤ 24 points); *B* = unstandardized regression coefficient; *CI* = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = standard error of the coefficient; β = standardized coefficient

Completers – model 3b

CY-BOCS	<i>B</i>	<u>95% <i>CI</i> for <i>B</i></u>		<i>SE B</i>	β	<i>p</i>	R^2	ΔR^2
End-of-treatment		<i>LL</i>	<i>UL</i>					
Model							0.15	0.08
Constant	5.20	-6.36	16.76	5.76		0.371		
Allocation	2.17	-12.95	17.28	7.53	0.16	0.774		
CY-BOCS baseline	2.03	-1.58	5.64	1.80	0.15	0.265		
DERS-T baseline	0.11	-0.03	0.25	0.07	0.33	0.113		
Allocation*DERS	-0.06	-0.23	0.12	0.09	-0.38	0.529		

Note. Allocation: FCBT = 1 versus FPRT = 0; Difficulties in Emotion Regulation Scale total score;

³Children's Yale-Brown Obsessive-Compulsive Scale (16 to 23 vs. ≤ 24 points); *B* = unstandardized regression coefficient; *CI* = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = standard error of the coefficient; β = standardized coefficient

Model 3c - all participants

A mixed-effects linear model assessed whether pre-treatment emotion dysregulation moderated symptom change over time (weeks 0, 4, 8, 16). The interaction between time and baseline DERS-T was non-significant ($p = .112$), indicating that baseline emotion dysregulation did not moderate symptom change during treatment.

CY-BOCS (0, 4, 8, 16)	<i>Estimate</i>	<u>95% CI</u>		<i>SE</i>	<i>t</i>	<i>p</i>
		<i>LL</i>	<i>UL</i>			
Model						
Constant	17.93	12.46	23.40	2.77	6.48	<.001
Time	-0.48	-2.89	1.93	1.22	-0.39	0.697
DERS-T baseline	0.12	0.05	0.18	0.03	3.66	<.001
Time*DERS	-0.02	-0.05	0.01	0.01	-1.60	.112

Note. DERS = Difficulties in Emotion Regulation Scale; *CI* = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE* = standard error of the estimate

Completers - model 3c

CY-BOCS	<i>Estimate</i>	<u>95% CI</u>		<i>SE</i>	<i>t</i>	<i>p</i>
(0, 4, 8, 16)		<i>LL</i>	<i>UL</i>			
Model						
Constant	20.83	14.44	27.27	3.23	6.45	<.001
Time	-2.06	-4.67	0.55	1.32	-1.56	0.121
DERS-T baseline	0.08	0.00	0.15	0.04	2.08	0.040
Time*DERS	-0.01	-0.04	0.02	0.02	-0.38	0.705

Note. DERS = Difficulties in Emotion Regulation Scale; *CI* = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE* = standard error of the estimate

Model 3d - by allocation

A mixed-effects linear model assessed differences between treatment groups in how pre-treatment emotion dysregulation moderated symptom change over time (weeks 0, 4, 8, 16). The interaction between treatment group and baseline DERS-T was significant, however with a confidence interval crossing 0 ($p = .049$, 95% CI [-.116, .000]), indicating no group differences in how baseline emotion dysregulation influenced OCD symptom change.

CY-BOCS (0, 4, 8, 16)	<i>Estimate</i>	<u>95% CI</u>		<i>SE</i>	<i>t</i>	<i>p</i>
		<i>LL</i>	<i>UL</i>			
Model						
Constant	19.48	15.42	23.50	2.05	9.48	<.001
DERS-T baseline	0.11	0.06	0.15	0.02	4.73	<.001
Allocation	3.01	-2.05	8.07	2.57	1.17	.242
Time	-2.38	-2.96	-1.79	0.29	-7.99	<.001
Allocation*DERS	-0.06	-0.12	0.00	0.03	-1.98	.049

Note. Allocation (FCBT = 1 versus FPRT = 0); DERS = Difficulties in Emotion Regulation Scale total score; CI = confidence interval; LL = lower limit; UL = upper limit; SE B = standard error of the estimate.

Completers - model 3d

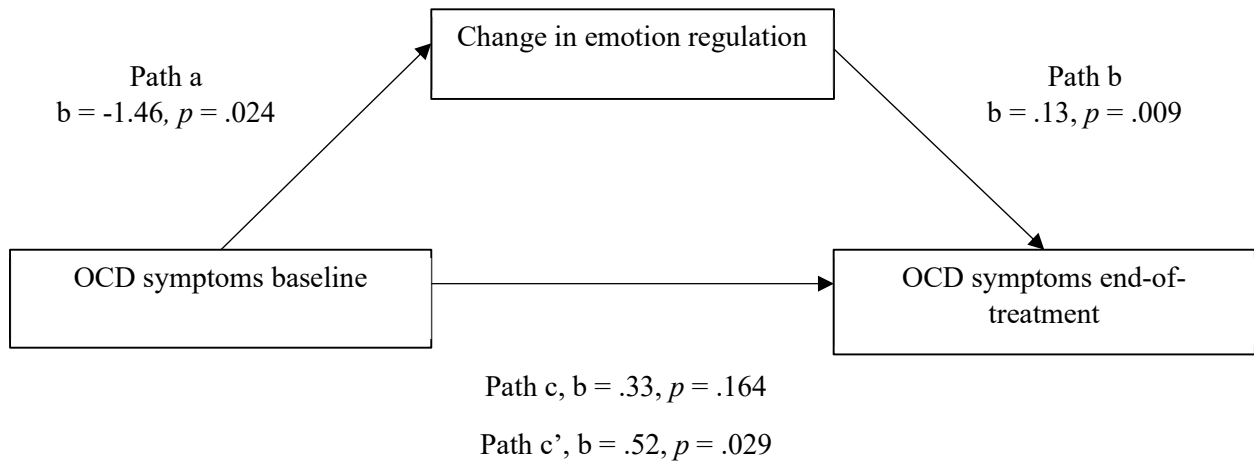
CY-BOCS (0, 4, 8, 16)	<i>Estimate</i>	<u>95% CI</u>		<i>SE</i>	<i>t</i>	<i>p</i>
		<i>LL</i>	<i>UL</i>			
Model						
Constant	20.75	16.26	25.24	2.28	9.11	<.001
DERS-T baseline	0.09	0.04	0.14	0.03	3.47	<.001
Allocation	1.81	-3.88	7.50	2.89	0.63	.532
Time	-2.55	-3.14	-1.96	0.30	-8.52	<.001
Allocation*DERS	-0.04	-0.11	0.03	0.03	-1.19	.234

Note. Allocation (FCBT = 1 versus FPRT = 0); DERS = Difficulties in Emotion Regulation Scale total score; CI = confidence interval; LL = lower limit; UL = upper limit; SE B = standard error of the estimate.

4. Emotion regulation as mediator

Model 4a - all participants

Mediation model of the indirect effect of emotion regulation change on treatment outcome – all participants



Step 1 path c – OCD at baseline did not significantly predict OCD at end-of-treatment

CY-BOCS (week 16)	<i>Estimates¹</i>	<u>95% CI for β</u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	8.96	-2.77	20.69	.131
CY-BOCS (week 0)	.33	-.14	.80	.164
Observations	55			
R2	.04			

¹ Estimates are the unstandardized beta coefficients.

Step 2 path a – OCD at baseline significantly predicted change in emotion regulation

DERS Δ	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	25.49	-6.13	57.12	.111
CY-BOCS (week 0)	-1.46	-2.72	-.20	.024
Observations	55			
R2	.09			

¹ Estimates are the unstandardized beta coefficients.

Step 3 & 4 path b & c' – OCD end-of-treatment was predicted by emotion regulation change and OCD baseline when accounting for each respectively.

CYBOCS (week 16)	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	5.64	-5.73	17.01	.324
DERS Δ	.13	.03	.23	.009
CY-BOCS (week 0)	.52	.06	.98	.029
Observations	55			
R2	.16			

¹ Estimates for are the unstandardized beta coefficients.

Estimated by PROCESS Macro (version 4.2, model 4) in SPSS indirect effect = -.19, Bootstrapped SE = .16, 95% CI -.58 to .04.

Completers - model 4a

Step 1 path c – OCD at baseline did not significantly predict OCD at end-of-treatment

CY-BOCS (week 16)	<i>Estimates¹</i>	<u>95% CI for β</u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	8.51	-2.15	19.18	.115
CY-BOCS (week 0)	.32	-.11	.75	.138
Observations	47			
R2	.04			

¹ Estimates for are the unstandardized beta coefficients.

Step 2 path a – OCD at baseline did not significantly predict change in emotion regulation

DERS Δ	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	15.35	-17.01	4772	.344
CY-BOCS (week 0)	-1.08	-2.38	-.27	.103

Observations	47
R2	.06

¹ Estimates for are the unstandardized beta coefficients.

Step 3 & 4 path b & c' –OCD end-of-treatment was not predicted by emotion regulation change and OCD baseline when accounting for each respectively.

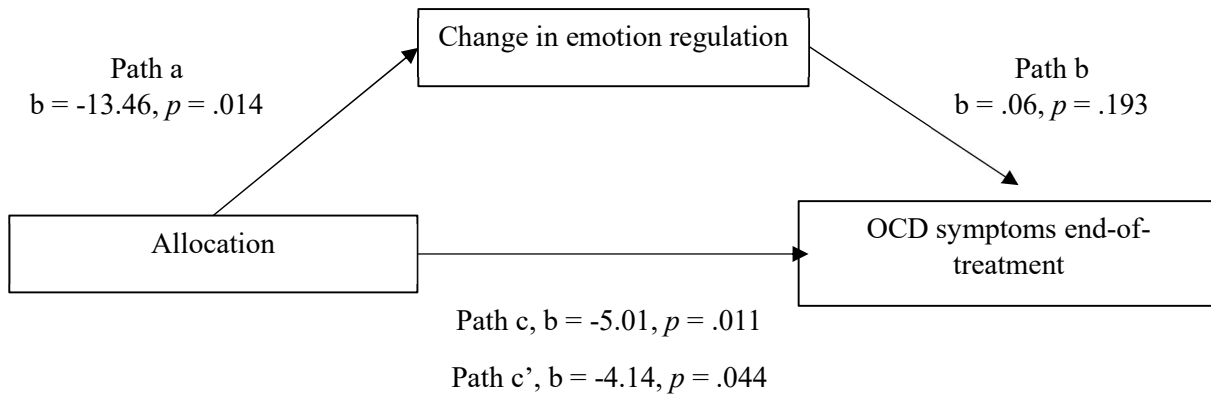
CYBOCS (week 16)	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	8.10	-2.76	18.97	.140
DERS Δ	.02	-.07	.79	.121
CY-BOCS (week 0)	.35	-.09	.12	.596
Observations	47			
R2	.05			

¹ Estimates for are the unstandardized beta coefficients.

Estimated by PROCESS Macro (version 4.2, model 4) in SPSS indirect effect = -.02, Bootstrapped SE = .05, 95% CI -.13 to .05.

Model 4b - by allocation

Mediation model of the indirect effect of emotion regulation change on treatment outcome – by allocation all participants



Step 1 path c – Allocation significantly predicted OCD symptoms at end-of-treatment

CY-BOCS (week 16)	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	19.73	16.94	22.52	<.001
Allocation	-5.01	-8.85	-1.17	.011
Observations	55			
R2/R2 adjusted	.11/.10			

¹ Estimates are the unstandardized beta coefficients.

Step 2 path a – Allocation significantly predicted change in emotion regulation

DERS Δ	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	-3.46	-11.24	4.31	.375
Allocation	-13.46	-24.16	-2.73	.014
Observations	55			
R2/R2 adjusted	.11/.09			

¹ Estimates are the unstandardized beta coefficients.

Step 3 & 4 path b & c' – OCD symptoms at end-of-treatment was significantly predicted by emotion regulation change when accounting for allocation. However, allocation no longer predicted OCD symptoms end-of-treatment when accounting for emotion regulation change.

CYBOCS (week 16)	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	

Intercept	19.95	17.16	22.75	<.001
DERS Δ	.06	-.03	.16	.193
Allocation	-4.14	-8.18	-.10	.044
Observations	55			
R2/R2 adjusted	.12/.09			

¹ Estimates are the unstandardized beta coefficients.

Estimated by PROCESS Macro (version 4.2, model 4) in SPSS indirect effect = -.87, Bootstrapped SE = .85, 95% CI -2.93 to .32.

Completers - model 4b

Step 1 path c – Allocation did not predict OCD symptoms at end-of-treatment

CY-BOCS (week 16)	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	17.63	14.98	20.28	<.001
Allocation	-2.35	-5.99	1.27	.198
Observations	47			
R2	.03			

¹ Estimates for are the unstandardized beta coefficients.

Step 2 path a – Allocation significantly predicted change in emotion regulation

DERS Δ	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	-5.00	-12.85	2.85	.206
Allocation	-11.26	-22.03	-.49	.040
Observations	55			
R2/R2 adjusted	.11/.09			

¹ Estimates for are the unstandardized beta coefficients.

Step 3 & 4 path b & c' – OCD symptoms at end-of-treatment were not predicted by allocation or change in emotion regulation when accounting for each respectively.

CYBOCS (week 16)	<i>Estimates¹</i>	<u>95% CI for <i>B</i></u>		<i>p</i>
		<i>LL</i>	<i>UL</i>	
Intercept	17.57	14.84	20.30	<.001
DERS Δ	-.01	-.11	.09	.809
Allocation	-2.49	-6.34	1.35	.198
Observations	47			
R ²	.03			

¹ Estimates for are the unstandardized beta coefficients.

For treatment completers, estimated by PROCESS Macro (version 4.2, model 4) in SPSS indirect effect = .13, Bootstrapped SE = .54, 95% CI -1.19 to 1.13.

Statistical report for Emotion dysregulation in youths with obsessive-compulsive disorder and its implication for treatment

Markus Harboe Olsen

2024-11-10

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Overview

Participants vs. Controls

	1 <i>n</i> = 79	2 <i>n</i> = 59
Sex - Male	39 (49.4%)	27 (45.8%)
Age - mean (95%CI)	14.4 (14.0;14.9)	14.4 (13.9;14.9)
DERS child non-acceptance (week 0) - mean (95%CI)	11.2 (10.1;12.4)	9.8 (8.9;10.8)
missing	0 (0%)	2 (3.4%)
DERS child goals (week 0) - mean (95%CI)	15.7 (14.7;16.8)	12.4 (11.3;13.5)
missing	0 (0%)	2 (3.4%)
DERS child impulse (week 0) - mean (95%CI)	12.9 (11.7;14.1)	8.8 (8.0;9.6)
missing	0 (0%)	2 (3.4%)
DERS child awareness (week 0) - mean (95%CI)	17.2 (16.2;18.2)	15.2 (14.3;16.0)
missing	0 (0%)	2 (3.4%)
DERS child strategy (week 0) - mean (95%CI)	18.2 (16.7;19.8)	13.3 (12.3;14.2)
missing	0 (0%)	2 (3.4%)
DERS child clarity (week 0) - mean (95%CI)	10.2 (9.5;10.9)	8.6 (7.9;9.3)
missing	0 (0%)	2 (3.4%)
DERS child total (week 0) - mean (95%CI)	85.5 (80.6;90.4)	68.1 (64.9;71.3)
missing	0 (0%)	2 (3.4%)
DERS child revised total (week 0) - mean (95%CI)	68.3 (63.7;72.8)	53.0 (49.9;56.0)
missing	0 (0%)	2 (3.4%)
DERS child non-acceptance (week 16) - mean (95%CI)	9.9 (8.8;11.0)	9.1 (8.2;10.0)
missing	24 (30.4%)	0 (0%)
DERS child goals (week 16) - mean (95%CI)	13.7 (12.4;15.0)	12.1 (11.1;13.2)
missing	24 (30.4%)	0 (0%)
DERS child impulse (week 16) - mean (95%CI)	11.1 (9.8;12.4)	8.9 (8.1;9.6)
missing	24 (30.4%)	0 (0%)
DERS child awareness (week 16) - mean (95%CI)	16.3 (15.3;17.4)	15.0 (13.8;16.3)
missing	24 (30.4%)	0 (0%)
DERS child strategy (week 16) - mean (95%CI)	15.1 (13.6;16.6)	13.1 (12.0;14.2)
missing	24 (30.4%)	0 (0%)
DERS child clarity (week 16) - mean (95%CI)	8.9 (8.1;9.7)	9.0 (8.3;9.6)
missing	24 (30.4%)	0 (0%)
DERS child total (week 16) - mean (95%CI)	75.1 (70.0;80.3)	67.2 (63.5;70.9)
missing	24 (30.4%)	0 (0%)
DERS child revised total (week 16) - mean (95%CI)	58.8 (54.1;63.5)	52.2 (49.2;55.1)
missing	24 (30.4%)	0 (0%)
DERS child total abnormal (week 0) - Abnormal	29 (36.7%)	4 (6.8%)
missing	0 (0.0%)	2 (3.4%)
DERS child total abnormal (week 16) - Abnormal	12 (15.2%)	5 (8.5%)
missing	24 (30.4%)	0 (0.0%)
DERS child revised total abnormal (week 0) - Abnormal	30 (38.0%)	4 (6.8%)
missing	0 (0.0%)	2 (3.4%)
DERS child revised total abnormal (week 16) - Abnormal	14 (17.7%)	4 (6.8%)
missing	24 (30.4%)	0 (0.0%)
DERS child total (change) - mean (95%CI)	-10.6 (-16.2;-5.0)	-1.3 (-4.0;1.4)
missing	24 (30.4%)	2 (3.4%)
DERS child revised total (change) - mean (95%CI)	-9.9 (-15.0;-4.8)	-1.1 (-3.3;1.2)
missing	24 (30.4%)	2 (3.4%)

Allocation

	FPRT <i>n</i> = 42	FCBT <i>n</i> = 37
Sex - Male	23 (54.8%)	16 (43.2%)
Age - mean (95%CI)	14.4 (13.8;15.0)	14.4 (13.8;15.1)
CY-BOCS (week 0) - mean (95%CI)	25.2 (23.7;26.7)	25.1 (23.6;26.6)
CY-BOCS (week 4) - mean (95%CI)	23.8 (22.0;25.6)	22.9 (21.0;24.7)
missing	1 (2.4%)	4 (10.8%)
CY-BOCS (week 8) - mean (95%CI)	22.7 (21.2;24.3)	18.9 (16.7;21.2)
missing	2 (4.8%)	3 (8.1%)
CY-BOCS (week 16) - mean (95%CI)	19.6 (16.9;22.3)	15.2 (12.6;17.7)
missing	7 (16.7%)	4 (10.8%)
DERS child non-acceptance (week 0) - mean (95%CI)	10.8 (9.4;12.2)	11.7 (9.8;13.5)
DERS child goals (week 0) - mean (95%CI)	15.7 (14.3;17.1)	15.8 (14.1;17.5)
DERS child impulse (week 0) - mean (95%CI)	12.7 (10.9;14.5)	13.0 (11.3;14.8)
DERS child awareness (week 0) - mean (95%CI)	16.6 (15.3;18.0)	17.9 (16.3;19.4)
DERS child strategy (week 0) - mean (95%CI)	17.6 (15.7;19.6)	18.9 (16.4;21.4)
DERS child clarity (week 0) - mean (95%CI)	10.0 (9.1;11.0)	10.4 (9.3;11.6)
DERS child total (week 0) - mean (95%CI)	83.5 (77.7;89.3)	87.7 (79.4;96.0)
DERS child revised total (week 0) - mean (95%CI)	66.9 (61.3;72.5)	69.9 (62.3;77.5)
DERS child non-acceptance (week 16) - mean (95%CI)	10.7 (8.8;12.5)	9.3 (7.9;10.7)
missing	16 (38.1%)	8 (21.6%)
DERS child goals (week 16) - mean (95%CI)	15.0 (13.3;16.6)	12.6 (10.7;14.5)
missing	16 (38.1%)	8 (21.6%)
DERS child impulse (week 16) - mean (95%CI)	12.7 (10.5;15.0)	9.6 (8.2;10.9)
missing	16 (38.1%)	8 (21.6%)
DERS child awareness (week 16) - mean (95%CI)	16.5 (15.0;18.0)	16.2 (14.6;17.8)
missing	16 (38.1%)	8 (21.6%)
DERS child strategy (week 16) - mean (95%CI)	15.8 (13.8;17.8)	14.6 (12.3;16.8)
missing	16 (38.1%)	8 (21.6%)
DERS child clarity (week 16) - mean (95%CI)	9.6 (8.3;10.9)	8.3 (7.3;9.4)
missing	16 (38.1%)	8 (21.6%)
DERS child total (week 16) - mean (95%CI)	80.2 (72.7;87.7)	70.5 (63.4;77.6)
missing	16 (38.1%)	8 (21.6%)
DERS child revised total (week 16) - mean (95%CI)	63.7 (56.8;70.6)	54.3 (48.0;60.6)
missing	16 (38.1%)	8 (21.6%)
CY-BOCS (strata) - mean (95%CI)	0.4 (0.2;0.5)	0.4 (0.3;0.6)
DERS child total abnormal (week 0) - Abnormal	16 (38.1%)	13 (35.1%)
DERS child total abnormal (week 16) - Abnormal	7 (16.7%)	5 (13.5%)
missing	16 (38.1%)	8 (21.6%)
DERS child revised total abnormal (week 0) - Abnormal	16 (38.1%)	14 (37.8%)
DERS child revised total abnormal (week 16) - Abnormal	10 (23.8%)	4 (10.8%)
missing	16 (38.1%)	8 (21.6%)
DERS child total (change) - mean (95%CI)	-3.5 (-9.7;2.8)	-16.9 (-25.6;-8.2)
missing	16 (38.1%)	8 (21.6%)
DERS child revised total (change) - mean (95%CI)	-3.0 (-9.0;2.9)	-16.0 (-23.8;-8.3)
missing	16 (38.1%)	8 (21.6%)

Completer vs non-completer

	Non-completers <i>n</i> = 22	Completers <i>n</i> = 57
Sex - Male	11 (50.0%)	28 (49.1%)
Age - mean (95%CI)	14.7 (13.9;15.6)	14.3 (13.8;14.8)
CY-BOCS (week 0) - mean (95%CI)	26.6 (24.3;28.9)	24.6 (23.4;25.7)
CY-BOCS (week 4) - mean (95%CI)	25.4 (23.0;27.8)	22.8 (21.3;24.2)
missing	4 (18.2%)	1 (1.8%)
CY-BOCS (week 8) - mean (95%CI)	23.4 (19.3;27.6)	20.2 (18.9;21.5)
missing	4 (18.2%)	1 (1.8%)
CY-BOCS (week 16) - mean (95%CI)	22.9 (15.4;30.4)	16.4 (14.6;18.2)
missing	11 (50%)	0 (0%)
DERS child non-acceptance (week 0) - mean (95%CI)	12.6 (9.9;15.3)	10.7 (9.5;11.9)
DERS child goals (week 0) - mean (95%CI)	15.8 (13.9;17.7)	15.7 (14.4;17.0)
DERS child impulse (week 0) - mean (95%CI)	14.0 (11.3;16.7)	12.4 (11.1;13.8)
DERS child awareness (week 0) - mean (95%CI)	18.2 (16.1;20.3)	16.8 (15.7;18.0)
DERS child strategy (week 0) - mean (95%CI)	17.9 (14.5;21.4)	18.3 (16.6;20.1)
DERS child clarity (week 0) - mean (95%CI)	11.0 (9.4;12.7)	9.9 (9.1;10.7)
DERS child total (week 0) - mean (95%CI)	89.6 (78.1;101.1)	83.9 (78.6;89.2)
DERS child revised total (week 0) - mean (95%CI)	71.4 (61.1;81.7)	67.1 (62.0;72.2)
DERS child non-acceptance (week 16) - mean (95%CI)	11.5 (7.1;15.9)	9.7 (8.5;10.8)
missing	14 (63.6%)	10 (17.5%)
DERS child goals (week 16) - mean (95%CI)	15.8 (11.4;20.1)	13.4 (12.0;14.7)
missing	14 (63.6%)	10 (17.5%)
DERS child impulse (week 16) - mean (95%CI)	14.5 (8.2;20.8)	10.5 (9.3;11.7)
missing	14 (63.6%)	10 (17.5%)
DERS child awareness (week 16) - mean (95%CI)	19.0 (16.3;21.7)	15.9 (14.7;17.1)
missing	14 (63.6%)	10 (17.5%)
DERS child strategy (week 16) - mean (95%CI)	17.9 (14.0;21.7)	14.7 (13.0;16.3)
missing	14 (63.6%)	10 (17.5%)
DERS child clarity (week 16) - mean (95%CI)	12.2 (9.2;15.3)	8.4 (7.6;9.1)
missing	14 (63.6%)	10 (17.5%)
DERS child total (week 16) - mean (95%CI)	90.8 (72.7;109.0)	72.4 (67.3;77.6)
missing	14 (63.6%)	10 (17.5%)
DERS child revised total (week 16) - mean (95%CI)	71.8 (55.4;88.3)	56.5 (51.8;61.3)
missing	14 (63.6%)	10 (17.5%)
CY-BOCS (strata) - mean (95%CI)	0.3 (0.1;0.5)	0.5 (0.3;0.6)
DERS child total abnormal (week 0) - Abnormal	8 (36.4%)	21 (36.8%)
DERS child total abnormal (week 16) - Abnormal	3 (13.6%)	9 (15.8%)
missing	14 (63.6%)	10 (17.5%)
DERS child revised total abnormal (week 0) - Abnormal	9 (40.9%)	21 (36.8%)
DERS child revised total abnormal (week 16) - Abnormal	3 (13.6%)	11 (19.3%)
missing	14 (63.6%)	10 (17.5%)
DERS child total (change) - mean (95%CI)	-8.0 (-33.6;17.7)	-11.0 (-16.6;-5.4)
missing	14 (63.6%)	10 (17.5%)
DERS child revised total (change) - mean (95%CI)	-7.4 (-29.5;14.7)	-10.3 (-15.5;-5.1)
missing	14 (63.6%)	10 (17.5%)

1. Change in emotion dysregulation after treatment

Model 1a - all participants

	week 0 <i>n</i> = 79	week 16 <i>n</i> = 79	Paired t-test mean diff. (95%CI)	<i>p</i>
DERS child total - mean (95%CI)	85.7 (79.5;91.8)	75.1 (70.0;80.3)	-10.6 (-16.2;-5.0)	0.000
missing	24 (30.4%)	24 (30.4%)		
DERS child revised total - mean (95%CI)	68.6 (63.1;74.2)	58.8 (54.1;63.5)	-9.9 (-15.0;-4.8)	0.000
missing	24 (30.4%)	24 (30.4%)		
NA -				

Completers - Model 1a

	week 0 <i>n</i> = 57	week 16 <i>n</i> = 57	Paired t-test mean diff. (95%CI)	<i>p</i>
DERS child total - mean (95%CI)	83.4 (77.6;89.3)	72.4 (67.3;77.6)	-11.0 (-16.6;-5.4)	0.000
missing	10 (17.5%)	10 (17.5%)		
DERS child revised total - mean (95%CI)	66.8 (61.4;72.3)	56.5 (51.8;61.3)	-10.3 (-15.5;-5.1)	0.000
missing	10 (17.5%)	10 (17.5%)		
NA -				

Model 1b - by allocation

	FPRT <i>n</i> = 42	FCBT <i>n</i> = 37	Linear regression estimate (95%CI)	<i>p</i>
DERS child total (week 16) - mean (95%CI)	80.23 (72.74;87.72)	70.52 (63.42;77.62)	-11.56 (-20.23;-2.89)	0.010
missing	16 (38.1%)	8 (21.6%)		
DERS child revised total (week 16) - mean (95%CI)	63.73 (56.82;70.64)	54.31 (47.99;60.63)	-11.37 (-19.20;-3.55)	0.005
missing	16 (38.1%)	8 (21.6%)		

Completer - Model 1b

	FPRT <i>n</i> = 29	FCBT <i>n</i> = 28	Linear regression estimate (95%CI)	<i>p</i>
DERS child total (week 16) - mean (95%CI)	77.55 (69.91;85.18)	67.93 (61.02;74.84)	-10.42 (-19.15;-1.68)	0.021
missing	7 (24.1%)	3 (10.7%)		
DERS child revised total (week 16) - mean (95%CI)	61.55 (54.43;68.66)	52.13 (45.89;58.37)	-10.25 (-18.22;-2.27)	0.013
missing	7 (24.1%)	3 (10.7%)		

2. Normative levels of emotion regulation after treatment

Upper threshold for abnormal values:

- DERS child total: 90.60952
- DERS child revised total: 70.93738

Model 2a - all participants

	week 0 <i>n</i> = 79	week 16 <i>n</i> = 79	McNemar's test <i>p</i> -value
DERS child total abnormal			0.022
Abnormal	20 (25.3%)	12 (15.2%)	
Normal	35 (44.3%)	43 (54.4%)	
missing	24 (30.4%)	24 (30.4%)	
DERS child revised total abnormal			0.039
Abnormal	21 (26.6%)	14 (17.7%)	
Normal	34 (43.0%)	41 (51.9%)	
missing	24 (30.4%)	24 (30.4%)	
NA -			

Completer - Model2a

	week 0 <i>n</i> = 57	week 16 <i>n</i> = 57	McNemar's test <i>p</i> -value
DERS child total abnormal			0.039
Abnormal	16 (28.1%)	9 (15.8%)	
Normal	31 (54.4%)	38 (66.7%)	
missing	10 (17.5%)	10 (17.5%)	
DERS child revised total abnormal			0.065
Abnormal	17 (29.8%)	11 (19.3%)	
Normal	30 (52.6%)	36 (63.2%)	
missing	10 (17.5%)	10 (17.5%)	
NA -			

Model 2b - by allocation

	FPRT <i>n</i> = 42	FCBT <i>n</i> = 37	Logistic regression <i>RR</i> (95% <i>CI</i>)	<i>p</i>
DERS child total abnormal (week 16)			0.76 (0.29;1.91)	0.571
Normal	19 (45.2%)	24 (64.9%)		
Abnormal	7 (16.7%)	5 (13.5%)		
missing	16 (38.1%)	8 (21.6%)		
DERS child revised total abnormal (week 16)			0.37 (0.14;0.87)	0.035
Normal	16 (38.1%)	25 (67.6%)		
Abnormal	10 (23.8%)	4 (10.8%)		
missing	16 (38.1%)	8 (21.6%)		

Completer - Model2b

	FPRT <i>n</i> = 29	FCBT <i>n</i> = 28	Logistic regression <i>RR</i> (95% <i>CI</i>)	<i>p</i>
DERS child total abnormal (week 16)			0.84 (0.27;2.51)	0.759
Normal	17 (58.6%)	21 (75.0%)		
Abnormal	5 (17.2%)	4 (14.3%)		
missing	7 (24.1%)	3 (10.7%)		

	FPRT <i>n = 29</i>	FCBT <i>n = 28</i>	Logistic regression <i>RR (95%CI)</i>	<i>p</i>
DERS child revised total abnormal (week 16)			0.34 (0.11;0.90)	0.046
Normal	14 (48.3%)	22 (78.6%)		
Abnormal	8 (27.6%)	3 (10.7%)		
missing	7 (24.1%)	3 (10.7%)		

3. The moderating effect of pre-treatment emotion dysregulation on treatment outcome and symptom change

Model 3a - all participants

Predictors	Estimates	CI	p
(Intercept)	-30.18	-77.16 – 16.80	0.204
DERS child total (week 0)	0.39	-0.11 – 0.90	0.123
CY-BOCS (week 0)	1.88	-0.01 – 3.78	0.051
DERS child total (week 0) × CY-BOCS (week 0)	-0.02	-0.03 – 0.00	0.126
Observations	68		
R2 / R2 adjusted	0.106 / 0.064		

Predictors	Estimates	CI	p
(Intercept)	-19.89	-60.61 – 20.83	0.333
DERS child revised total(week 0)	0.35	-0.18 – 0.89	0.196
CY-BOCS (week 0)	1.46	-0.17 – 3.09	0.079
DERS child revised total(week 0) × CY-BOCS (week0)	-0.01	-0.03 – 0.01	0.204
Observations	68		
R2 / R2 adjusted	0.096 / 0.054		

Completer - Model 3a

Predictors	Estimates	CI	p
(Intercept)	-5.20	-51.69 – 41.28	0.823
DERS child total (week 0)	0.18	-0.32 – 0.67	0.481
CY-BOCS (week 0)	0.63	-1.28 – 2.54	0.510
DERS child total (week 0) × CY-BOCS (week 0)	-0.00	-0.02 – 0.02	0.676
Observations	57		
R2 / R2 adjusted	0.101 / 0.050		

Predictors	Estimates	CI	p
(Intercept)	-0.34	-39.76 – 39.07	0.986
DERS child revised total(week 0)	0.15	-0.37 – 0.66	0.571
CY-BOCS (week 0)	0.49	-1.12 – 2.09	0.546
DERS child revised total(week 0) × CY-BOCS (week0)	-0.00	-0.02 – 0.02	0.767
Observations	57		
R2 / R2 adjusted	0.094 / 0.043		

Model 3b - by allocation

Predictors	Estimates	CI	p
(Intercept)	-0.08	-13.53 – 13.37	0.991
DERS child total (week 0)	0.12	-0.02 – 0.25	0.086
Allocation [FCBT]	8.95	-5.45 – 23.34	0.219
CY-BOCS (week 0)	0.39	-0.06 – 0.83	0.086
DERS child total (week 0) × Allocation [FCBT]	-0.16	-0.32 – 0.01	0.061
Observations	68		
R2 / R2 adjusted	0.196 / 0.145		

Predictors	Estimates	CI	p
(Intercept)	1.15	-11.30 – 13.59	0.855
DERS child revised total(week 0)	0.12	-0.01 – 0.26	0.077
Allocation [FCBT]	7.43	-4.80 – 19.65	0.229
CY-BOCS (week 0)	0.40	-0.03 – 0.84	0.070
DERS child revised total(week 0) × Allocation[FCBT]	-0.17	-0.34 – -0.00	0.049
Observations	68		
R2 / R2 adjusted	0.201 / 0.150		

Completer - Model 3b

Predictors	Estimates	CI	p
(Intercept)	2.77	-10.62 – 16.17	0.680
DERS child total (week 0)	0.11	-0.03 – 0.25	0.109
Allocation [FCBT]	2.60	-12.48 – 17.67	0.731
CY-BOCS (week 0)	0.22	-0.20 – 0.65	0.296
DERS child total (week 0) × Allocation [FCBT]	-0.06	-0.24 – 0.11	0.477
Observations	57		
R2 / R2 adjusted	0.146 / 0.080		

Predictors	Estimates	CI	p
(Intercept)	3.23	-9.12 – 15.57	0.602
DERS child revised total(week 0)	0.13	-0.01 – 0.27	0.078
Allocation [FCBT]	3.77	-8.84 – 16.39	0.551
CY-BOCS (week 0)	0.24	-0.18 – 0.66	0.254
DERS child revised total(week 0) × Allocation[FCBT]	-0.09	-0.28 – 0.09	0.298
Observations	57		
R2 / R2 adjusted	0.149 / 0.084		

Model 3c - all participants

Predictors	Estimates	CI	p
(Intercept)	17.97	13.41 – 22.52	<0.001
DERS child total (week 0)	0.08	0.03 – 0.14	0.001
time	-0.20	-0.58 – 0.18	0.297
DERS child total (week 0) × time	-0.00	-0.01 – 0.00	0.137
Random Effects			
2	23.01		
00pt_id	11.14		
ICC	0.33		
N pt_id	79		
Observations	295		
Marginal R2 / Conditional R2	0.225 / 0.478		

Predictors	Estimates	CI	p
(Intercept)	19.69	15.72 – 23.66	<0.001
DERS child revised total(week 0)	0.08	0.02 – 0.14	0.005
time	-0.28	-0.61 – 0.05	0.095
DERS child revised total(week 0) × time	-0.00	-0.01 – 0.00	0.209
Random Effects			
2	23.09		
00pt_id	11.44		
ICC	0.33		
N pt_id	79		
Observations	295		
Marginal R2 / Conditional R2	0.216 / 0.476		

Completer - Model 3c

Predictors	Estimates	CI	p
(Intercept)	19.36	14.16 – 24.56	<0.001
DERS child total (week 0)	0.06	0.00 – 0.12	0.042
time	-0.58	-0.98 – -0.18	0.005
DERS child total (week 0) × time	0.00	-0.00 – 0.01	0.752
Random Effects			
2	17.22		
00pt_id	10.32		
ICC	0.37		
N pt_id	57		
Observations	226		
Marginal R2 / Conditional R2	0.291 / 0.557		

Predictors	Estimates	CI	p
(Intercept)	20.96	16.55 – 25.38	<0.001
DERS child revised total(week 0)	0.05	-0.01 – 0.12	0.092
time	-0.58	-0.92 – -0.24	0.001
DERS child revised total(week 0) × time	0.00	-0.00 – 0.01	0.702
Random Effects			
2	17.22		
00pt_id	10.79		
ICC	0.39		
N pt_id	57		
Observations	226		
Marginal R2 / Conditional R2	0.279 / 0.557		

Model 3d - by allocation

Predictors	Estimates	CI	p
(Intercept)	16.70	11.11 – 22.30	<0.001
DERS child total (week 0)	0.11	0.05 – 0.18	0.001
Allocation [FCBT]	4.03	-3.28 – 11.34	0.279
time	-0.48	-0.58 – -0.39	<0.001
DERS child total (week 0) × Allocation [FCBT]	-0.08	-0.16 – 0.01	0.077
Random Effects			
2	23.20		
00pt_id	9.32		
ICC	0.29		
N pt_id	79		
Observations	295		
Marginal R2 / Conditional R2	0.267 / 0.477		

Predictors	Estimates	CI	p
(Intercept)	19.12	14.33 – 23.90	<0.001
DERS child revised total(week 0)	0.10	0.04 – 0.17	0.003
Allocation [FCBT]	2.47	-3.90 – 8.83	0.446
time	-0.48	-0.58 – -0.39	<0.001
DERS child revised total(week 0) × Allocation[FCBT]	-0.07	-0.16 – 0.02	0.127
Random Effects			
2	23.21		
00pt_id	9.90		
ICC	0.30		
N pt_id	79		
Observations	295		
Marginal R2 / Conditional R2	0.254 / 0.477		

Completer - Model 3d

Predictors	Estimates	CI	p
(Intercept)	17.53	10.95 – 24.12	<0.001
DERS child total (week 0)	0.09	0.02 – 0.17	0.016
Allocation [FCBT]	2.06	-6.65 – 10.76	0.642
time	-0.52	-0.61 – -0.43	<0.001
DERS child total (week 0) × Allocation [FCBT]	-0.04	-0.15 – 0.06	0.383
Random Effects			
2	17.13		
00pt_id	9.90		
ICC	0.37		
N pt_id	57		
Observations	226		
Marginal R2 / Conditional R2	0.311 / 0.563		

Predictors	Estimates	CI	p
(Intercept)	19.85	14.21 – 25.48	<0.001
DERS child revised total(week 0)	0.08	0.00 – 0.16	0.044
Allocation [FCBT]	0.93	-6.52 – 8.39	0.806
time	-0.52	-0.61 – -0.43	<0.001
DERS child revised total(week 0) × Allocation[FCBT]	-0.04	-0.15 – 0.07	0.477
Random Effects			
2	17.13		
00pt_id	10.49		
ICC	0.38		
N pt_id	57		
Observations	226		
Marginal R2 / Conditional R2	0.297 / 0.564		

4. The mediating effect of changes in emotion dysregulation on treatment outcome

Model 4a - all participants

Step 1 - path c

Children above 11 years old:

Predictors	Estimates	CI	p
(Intercept)	5.59	-5.04 – 16.22	0.298
CY-BOCS (week 0)	0.48	0.06 – 0.90	0.027
Observations	68		
R2 / R2 adjusted	0.072 / 0.058		

Only 55 participants

Children above 11 years old:

Predictors	Estimates	CI	p
(Intercept)	8.96	-2.77 – 20.69	0.132
CY-BOCS (week 0)	0.33	-0.14 – 0.80	0.164
Observations	55		
R2 / R2 adjusted	0.036 / 0.018		

Step 2 - path a

DERS child total (change)

Predictors	Estimates	CI	p
(Intercept)	25.49	-6.13 – 57.12	0.112
CY-BOCS (week 0)	-1.46	-2.72 – -0.20	0.024
Observations	55		
R2 / R2 adjusted	0.092 / 0.075		

DERS child revised total (change)

Predictors	Estimates	CI	p
(Intercept)	21.04	-7.98 – 50.06	0.152
CY-BOCS (week 0)	-1.25	-2.41 – -0.09	0.035
Observations	55		
R2 / R2 adjusted	0.082 / 0.064		

Step 3 - path b

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	5.64	-5.73 – 17.01	0.324
DERS child total (change)	0.13	0.03 – 0.23	0.009
CY-BOCS (week 0)	0.52	0.05 – 0.98	0.029
Observations	55		
R2 / R2 adjusted	0.155 / 0.122		

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	5.84	-5.40 – 17.08	0.302
DERS child revised total(change)	0.15	0.04 – 0.25	0.006
CY-BOCS (week 0)	0.52	0.06 – 0.97	0.029
Observations	55		
R2 / R2 adjusted	0.166 / 0.134		

Step 4 - path c'

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	5.64	-5.73 – 17.01	0.324
DERS child total (change)	0.13	0.03 – 0.23	0.009
CY-BOCS (week 0)	0.52	0.05 – 0.98	0.029
Observations	55		
R2 / R2 adjusted	0.155 / 0.122		

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	5.84	-5.40 – 17.08	0.302
DERS child revised total(change)	0.15	0.04 – 0.25	0.006
CY-BOCS (week 0)	0.52	0.06 – 0.97	0.029
Observations	55		
R2 / R2 adjusted	0.166 / 0.134		

Completer - Model 4a

Step 1 - path c

Children above 11 years old:

Predictors	Estimates	CI	p
(Intercept)	7.48	-2.63 – 17.59	0.144
CY-BOCS (week 0)	0.36	-0.04 – 0.77	0.078
Observations	57		
R2 / R2 adjusted	0.055 / 0.038		

Step 2 - path a

DERS child total (change)

Predictors	Estimates	CI	p
(Intercept)	15.35	-17.01 – 47.72	0.344
CY-BOCS (week 0)	-1.08	-2.38 – 0.23	0.103
Observations	47		
R2 / R2 adjusted	0.058 / 0.037		

DERS child revised total (change)

Predictors	Estimates	CI	p
(Intercept)	13.92	-16.25 – 44.09	0.358
CY-BOCS (week 0)	-0.99	-2.21 – 0.23	0.108
Observations	47		
R2 / R2 adjusted	0.056 / 0.035		

Step 3 - path b

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	8.11	-2.76 – 18.98	0.140
DERS child total (change)	0.03	-0.07 – 0.13	0.597
CY-BOCS (week 0)	0.35	-0.10 – 0.80	0.121
Observations	47		
R2 / R2 adjusted	0.054 / 0.011		

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	7.95	-2.88 – 18.78	0.146
DERS child revised total(change)	0.04	-0.07 – 0.15	0.453
CY-BOCS (week 0)	0.36	-0.08 – 0.81	0.109
Observations	47		
R2 / R2 adjusted	0.060 / 0.018		

Step 4 - path c'

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	8.11	-2.76 – 18.98	0.140
DERS child total (change)	0.03	-0.07 – 0.13	0.597
CY-BOCS (week 0)	0.35	-0.10 – 0.80	0.121
Observations	47		
R2 / R2 adjusted	0.054 / 0.011		

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	7.95	-2.88 – 18.78	0.146
DERS child revised total(change)	0.04	-0.07 – 0.15	0.453
CY-BOCS (week 0)	0.36	-0.08 – 0.81	0.109
Observations	47		
R2 / R2 adjusted	0.060 / 0.018		

Model 4b - by allocation

Step 1 - path c

Children above 11 years old:

Predictors	Estimates	CI	p
(Intercept)	19.63	17.07 – 22.18	<0.001
Allocation [FCBT]	-4.48	-8.14 – -0.81	0.017
Observations	68		
R2 / R2 adjusted	0.083 / 0.069		

Step 2 - path a

DERS child total (change)

Predictors	Estimates	CI	p
(Intercept)	-3.47	-11.24 – 4.31	0.376
Allocation [FCBT]	-13.44	-24.16 – -2.73	0.015
Observations	55		
R2 / R2 adjusted	0.107 / 0.090		

DERS child revised total (change)

Predictors	Estimates	CI	p
(Intercept)	-3.02	-10.06 – 4.02	0.394
Allocation [FCBT]	-13.02	-22.71 – -3.32	0.009
Observations	55		
R2 / R2 adjusted	0.120 / 0.104		

Step 3 - path b

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	19.95	17.16 – 22.75	<0.001
DERS child total (change)	0.06	-0.03 – 0.16	0.193
Allocation [FCBT]	-4.14	-8.18 – -0.10	0.045
Observations	55		
R2 / R2 adjusted	0.143 / 0.110		

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	19.97	17.18 – 22.75	<0.001
DERS child revised total(change)	0.08	-0.03 – 0.19	0.154
Allocation [FCBT]	-3.99	-8.05 – 0.06	0.054
Observations	55		
R2 / R2 adjusted	0.149 / 0.116		

Step 4 - path c'

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	19.95	17.16 – 22.75	<0.001
DERS child total (change)	0.06	-0.03 – 0.16	0.193
Allocation [FCBT]	-4.14	-8.18 – -0.10	0.045
Observations	55		
R2 / R2 adjusted	0.143 / 0.110		

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	19.97	17.18 – 22.75	<0.001
DERS child revised total(change)	0.08	-0.03 – 0.19	0.154
Allocation [FCBT]	-3.99	-8.05 – 0.06	0.054
Observations	55		
R2 / R2 adjusted	0.149 / 0.116		

Completer - Model 4b

Step 1 - path c

Children above 11 years old:

Predictors	Estimates	CI	p
(Intercept)	17.69	15.23 – 20.15	<0.001
Allocation [FCBT]	-2.62	-6.12 – 0.89	0.140
Observations	57		
R2 / R2 adjusted	0.039 / 0.022		

Step 2 - path a

DERS child total (change)

Predictors	Estimates	CI	p
(Intercept)	-5.00	-12.86 – 2.85	0.206
Allocation [FCBT]	-11.27	-22.04 – -0.50	0.041
Observations	47		
R2 / R2 adjusted	0.090 / 0.070		

DERS child revised total (change)

Predictors	Estimates	CI	p
(Intercept)	-4.48	-11.76 – 2.81	0.222
Allocation [FCBT]	-10.95	-20.94 – -0.97	0.032
Observations	47		
R2 / R2 adjusted	0.098 / 0.078		

Step 3 - path b

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	17.57	14.85 – 20.30	<0.001
DERS child total (change)	-0.01	-0.11 – 0.09	0.810
Allocation [FCBT]	-2.50	-6.35 – 1.36	0.198
Observations	47		
R2 / R2 adjusted	0.038 / -0.006		

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	17.63	14.90 – 20.36	<0.001
DERS child revised total(change)	-0.00	-0.11 – 0.11	0.975
Allocation [FCBT]	-2.37	-6.25 – 1.50	0.223
Observations	47		
R2 / R2 adjusted	0.037 / -0.007		

Step 4 - path c'

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	17.57	14.85 – 20.30	<0.001
DERS child total (change)	-0.01	-0.11 – 0.09	0.810
Allocation [FCBT]	-2.50	-6.35 – 1.36	0.198
Observations	47		
R2 / R2 adjusted	0.038 / -0.006		

CY-BOCS (week 16)

Predictors	Estimates	CI	p
(Intercept)	17.63	14.90 – 20.36	<0.001
DERS child revised total(change)	-0.00	-0.11 – 0.11	0.975
Allocation [FCBT]	-2.37	-6.25 – 1.50	0.223
Observations	47		
R2 / R2 adjusted	0.037 / -0.007		

5. Stability of emotion regulation over time in controls

Model 5a

	week 0 <i>n</i> = 59	week 16 <i>n</i> = 59	Paired t-test mean diff. (95%CI)	<i>p</i>
DERS child total - mean (95%CI)	68.1 (64.9;71.3)	66.8 (63.1;70.6)	-1.3 (-4.0;1.4)	0.342
missing	2 (3.4%)	2 (3.4%)		
DERS child revised total - mean (95%CI)	53.0 (49.9;56.0)	51.9 (48.8;55.0)	-1.1 (-3.3;1.2)	0.351
missing	2 (3.4%)	2 (3.4%)		
NA -				

Model 5b - posthoc

**** DERS child total ****

Calculation of reliability between two measures (57 of 59 analysed):

- Smallest real difference (SRD; 95%CI): 20.3 (17.14;24.56)
- Coefficient of variance (CV; 95%CI): 10.62 (8.7;12.6)
- Intraclass correlation coefficient (ICC; 95%CI): 0.71 (0.55;0.82)
- Bland-Altman plot estimates - bias (95%LOA): -1.3 (-21.2;18.6)

**** DERS child revised total ****

Calculation of reliability between two measures (57 of 59 analysed):

- Smallest real difference (SRD; 95%CI): 16.9 (13.88;21.19)
- Coefficient of variance (CV; 95%CI): 11.38 (9.3;13.5)
- Intraclass correlation coefficient (ICC; 95%CI): 0.73 (0.58;0.83)
- Bland-Altman plot estimates - bias (95%LOA): -1.1 (-17.6;15.5)

Supplementary material IV- Statistical models - Implications of emotion regulation difficulties for psychotherapy in pediatric OCD

This table is re-printed from the statistical analysis plan published prior to commencing the analyses for this study:
Thoustrup, C. L., Uhre, C., Uhre, V., Ritter, M., Vangkilde, S., Engstrøm, J., Lindschou, J., Gluud, C., Pagsberg, A. K., & Olsen, M. H. (2025). Emotion dysregulation in youths with obsessive-compulsive disorder and its implication for treatment - An exploratory study from the TECTO trial: A protocol and statistical analysis plan. *Contemporary Clinical Trials Communications*, 43, 101408. <https://doi.org/10.1016/j.conctc.2024.101408>

Change in emotion dysregulation after treatment	
Model 1a - all participants	Paired t-test comparing the mean difference between DERS-T at baseline and end-of-treatment H_0: DERS-T at baseline = DERS-T at end-of-treatment H_1: DERS-T at baseline $\neq$ DERS-T at end-of-treatment
Model 1b - by allocation	Linear regression model <i>Outcome</i>: DERS-T end-of-treatment <i>Fixed effects</i>: Allocation (0 = FPRT, 1 = FCBT), DERS-T at baseline; and CY-BOCS (16 to 23 compared to ≤ 24 points) at baseline
Normative levels of emotion regulation after treatment	
Model 2a – all participants	McNemar mid-p H_0: Proportion of ED_{pre} = Proportion of ED_{post} H_1: Proportion of ED_{pre} $\neq$ Proportion of ED_{post}
Model 2b – by allocation	Logistic regression model

	<i>Outcome:</i> Within or outside the reference interval from Study Norms <i>Fixed effects:</i> Allocation (0 = FPRT, 1 = FCBT), DERS-T at baseline, CY-BOCS (16 to 23 compared to ≤ 24 points) at baseline
The moderating effect of pre-treatment emotion dysregulation on treatment outcome and symptom change	
Model 3a – all participants	Linear regression model <i>Outcome:</i> CY-BOCS at end-of-treatment <i>Fixed effects:</i> DERS-T at baseline, CY-BOCS at baseline <i>Interaction link:</i> CY-BOCS at baseline and DERS-T at baseline
Model 3b – by allocation	Linear regression model <i>Outcome:</i> CY-BOCS at end-of-treatment <i>Fixed effects:</i> Allocation (0 = FPRT, 1 = FCBT), DERS-T at baseline, CY-BOCS (16 to 23 compared to ≤ 24 points) at baseline <i>Interaction link:</i> Allocation and DERS-T at baseline
Model 3c - all participants	Mixed effects linear regression model <i>Outcome:</i> CY-BOCS (week 0, 4, 8, 16) <i>Fixed effects:</i> Time (0, 4, 8, and 16 weeks), DERS-T at baseline <i>Random effects</i> (slope and intercept): Participant <i>Interaction link:</i> Time and DERS-T at baseline
Model 3d – by allocation	Mixed effects linear regression model

	<i>Outcome:</i> CY-BOCS (week 0, 4, 8, 16) <i>Fixed effects:</i> Allocation (0 = FPRT, 1 = FCBT), time (0, 4, 8, and 16 weeks), DERS-T at baseline <i>Random effects</i> (slope and intercept): Participant <i>Interaction link:</i> Allocation and DERS-T at baseline
The mediating effect of changes in emotion dysregulation on treatment outcome	
Model 4a – all participants	<i>Step 1 - path c</i> <i>Outcome:</i> CY-BOCS at end-of-treatment <i>Fixed effects:</i> CY-BOCS at baseline <i>Step 2 – path a</i> <i>Outcome:</i> DERS change (T2-T1) <i>Fixed effects:</i> CY-BOCS at baseline <i>Step 3 – path b</i> <i>Outcome:</i> CY-BOCS end-of-treatment <i>Fixed effects:</i> DERS change (T2-T1), CY-BOCS at baseline

	<i>Step 4 – path c'</i> <i>Outcome:</i> CY-BOCS at end-of-treatment <i>Fixed effects:</i> CY-BOCS at baseline, DERS change (T2-T1)
Model 4b – by allocation	<i>Step 1 - path c</i> <i>Outcome:</i> CY-BOCS at end-of-treatment <i>Fixed effects:</i> Allocation (0 = FPRT, 1 = FCBT) <i>Step 2 – path a</i> <i>Outcome:</i> DERS change (T2-T1) <i>Fixed effects:</i> Allocation (0 = FPRT, 1 = FCBT) <i>Step 3 – path b</i> <i>Outcome:</i> CY-BOCS end-of-treatment <i>Fixed effects:</i> DERS change (T2-T1), Allocation (0 = FPRT, 1 = FCBT) <i>Step 4 – path c'</i> <i>Outcome:</i> CY-BOCS at-end-of-treatment

	<i>Fixed effects:</i> Allocation (0 = FPRT, 1 = FCBT), DERS change (T2-T1)
Stability of emotion regulation over time in healthy controls	
Model 5	Paired t-test comparing the mean difference between DERS-T at baseline and end-of-study for healthy controls H₀: DERS-T at baseline = DERS-T at end-of-study H₁: DERS-T at baseline ≠ DERS-T at end-of-study