Doctoral theses at NTNU, 2023:2

Lucía Babiano-Espinosa

Enhanced Cognitive-Behavioural Therapy (eCBT) for Children and Adolescents with Obsessive- Compulsive Disorder

Doctoral thesis

NTNU
Norwegian University of Science and Technology
Thesis for the Degree of
Philosophiae Doctor
Faculty of Medicine and Health Sciences
Department of Mental Health

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Trondheim, January 2023

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Abstract

Obsessive compulsive disorder (OCD) is a chronic mental health disorder that is characterized by recurring obsessions and compulsions and it affects 1–3% of children and adolescents. Cognitive behavioural therapy (CBT) has been established as the therapeutic gold standard for paediatric OCD. However, CBT is not always accessible and available and the quality of the treatment can vary considerably. The aim of this Doctoral Thesis was to investigate how new technology could help to reduce shortcomings in traditional CBT for paediatric patients with OCD.

First, we carried out a systematic review on the acceptability, feasibility and efficacy of Internet CBT (iCBT) for paediatric OCD. Second, we developed an enhanced CBT (eCBT) treatment package for children and adolescents with OCD. This enhanced traditional face-to-face CBT by providing webcam sessions, psychoeducational videos, and a supportive mobile phone application (app). Third, we explored the acceptability, feasibility, and preliminary efficacy of the specially developed eCBT package.

Six studies with a total of 96 participants met the inclusion criteria for the systematic review. All six studies reported high feasibility and five studies reported that iCBT had good acceptability. The sixth study did not report acceptability. The studies reported that OCD symptoms were reduced following iCBT, but all of them had a low number of participants, which underlines the need for a more comprehensive and stronger evidence base for iCBT.

The second paper described our newly developed eCBT package for paediatric OCD and the protocol for evaluating the acceptability, feasibility, and

effectiveness of eCBT. In the third paper we described 25 children aged 8–17 years with OCD who received eCBT. All the children completed the treatment, which suggests that eCBT was a feasible intervention. Acceptability was high and, overall, both the children and their parents provided very positive feedback about the new intervention.

The fourth paper evaluated the eCBT outcomes for the same 25 patients and benchmarked them against the outcomes of the Nordic Long-term OCD Treatment Study (NordLOTS). This study focused on 269 patients who received traditional face-to-face CBT. The mean estimated difference of the Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS) total scores was -2.5, with a 95% confidence interval (CI) of -0.3 to 5.3 in favour of eCBT. This could indicate that eCBT was even more effective in reducing OCD symptoms than traditional face-to-face CBT. Future studies, such as randomized control trials (RCTs) with head-to-head comparisons, are needed to examine this further.

In conclusion, eCBT for pediatric OCD was feasible for clinical practice, users found it acceptable and provided very positive feedaback and it was not inferior to traditional face-to-face CBT treatment.

Norsk sammendrag

Digital forsterket kognitiv atferdsterapi (eCBT) for barn og ungdom med tvangslidelse

Tvangslidelse (på engelsk Obsessive-compulsive disorder, OCD) er en kronisk psykisk lidelse kjennetegnet av tilbakevendende tvangstanker (obsessions) og tvangshandlinger (compulsions). Tvangslidelse forekommer hos cirka 1–3% av barn og unge. Kognitiv atferdsterapi (KAT, på engelsk CBT) er gullstandart for behandling av tvangslidelse hos barn og unge. Imidlertid er tilgangen til denne behandlingen begrenset og kvaliteten i behandlingen kan være svært varierende. Denne avhandlingen har som mål å undersøke hvordan ny Internet-teknologi kan bidra til å redusere begrensninger av tradisjonell KAT.

Først undersøkte vi status av brukeraksept, gjennomførbarhet og effektivitet av Internetbaserte KAT-intervensjoner for OCD hos barn og unge i form av en systematisk oversiktsartikkel. Dernest utviklet vi en behandlingspakke for barn og unge med OCD, hvor tradisjonell KAT med direkte terapeutkontakt ble supplert med webkamera baserte behandlingstimer, psykoedukative videosnutter og en app som støtte for behandlingen («enhanced CBT» eller eCBT). Som tredje steg evaluerte vi om denne behandlingen var gjennomførbar i praksis, om brukerne opplevde den som nyttig og om behandlingsresultatene etter eCBT var like bra som ved tradisjonell KAT.

I den systematiske oversiktsartikkelen fant vi bare seks studier med til sammen 96 deltakere som fylte inklusjonskriteriene: Alle seks studiene rapporterte høy grad av gjennomførbarhet av Internetbaserte KAT intervensjoner (iCBT). Fem studier rapporterte også høy brukeraksept (én studie undersøkte ikke brukeraksept).

Alle studier beskrev reduksjon av OCD-symptomer etter behandlingen, men alle hadde lavt antall deltakere, noe som understreker behovet for flere studier og en større evidensbase for iCBT. I den andre artikkelen beskrev vi den nylig utviklete eCBT pakken og en protokoll for evaluering av brukeraksept, praktisk gjennomførbarhet og effektivitet av eCBT. I den tredje artikkelen beskrev vi 25 barn med OCD (alder 8–17 år) som fikk behandling med eCBT. Alle deltakere gjennomførte behandlingen, noe som tyder på at eCBT er en intervensjon som er gjennomførbar i klinisk praksis. Også brukeraksept var høy, både barn og unge og deres foreldre ga svært positive tilbakemeldinger.

I den fjerde artikkelen sammenliknet vi behandlingsresultatene etter eCBT av disse 25 barna med resultatene av standart KAT, dvs. timer med direkte kontakt fra en stor behandlingsstudie for OCD hos barn og unge (n=269), the Nordic Longterm OCD Treatment Study (NordLOTS) som referansepunkt i et såkalt «non-inferiority-design». Den gjennomsnittlige estimerte differensen i CY-BOCS total skårene var -2.5 (95% CI -0.3 til 5.3) til fordel for eCBT. Dette resultatet kunne tyde på at eCBT var faktisk mer effektiv for å redusere OCD symptomer enn standart KAT. Men dette må undersøkes nærmere i studier hvor man direkte sammenlikner resultatene etter å ha fordelt pasientene tilfeldig til eCBT eller en kontrollgruppe.

Konklusjon: eCBT for OCD hos barn og unge var gjennomførbar i klinisk praksis, fikk svært gode tilbakemeldinger av brukerne og hadde minst like god effekt som standard KAT.

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List of papers

Paper 1:

Lucía Babiano-Espinosa, Lidewij H. Wolters, Bernhard Weidle, Vivian op de Beek, Sindre A. Pedersen, Scott Compton, Norbert Skokauskas.

Acceptability, feasibility, and efficacy of Internet cognitive behavioral therapy (iCBT) for pediatric obsessive-compulsive disorder: a systematic review.

Syst Rev **8,** 284 (2019). https://doi.org/10.1186/s13643-019-1166-6

Paper 2:

Lidewij H. Wolters, Bernhard Weidle, Lucia Babiano-Espinosa, Norbert Skokauskas. **Feasibility, Acceptability, and Effectiveness of Enhanced Cognitive Behavioral Therapy (eCBT) for Children and Adolescents With Obsessive-Compulsive Disorder: Protocol for an Open Trial and Therapeutic Intervention.**

JMIR Res Protoc 2020;9(12):e24057. DOI: 10.2196/24057

Paper 3:

Lucía Babiano-Espinosa, Lidewij H. Wolters, Bernhard Weidle, Scott N. Compton, Stian Lydersen, Norbert Skokauskas.

Acceptability and feasibility of enhanced cognitive behavioral therapy (eCBT) for children and adolescents with obsessive–compulsive disorder.

Child Adolesc Psychiatry Ment Health **15,** 47 (2021). https://doi.org/10.1186/s13034-021-00400-7

Paper 4:

Lucía Babiano-Espinosa, Gudmundur Skarphedinsson, Bernhard Weidle, Lidewij H. Wolters, Tord Ivarsson, Norbert Skokauskas.

eCBT versus standard individual CBT for pediatric obsessive-compulsive disorder.

Child Psychiatry Hum Dev (2022). https://doi.org/10.1007/s10578-022-01350-7

Acronyms

ADHD*:* attention deficit hyperactivity disorder

app: mobile phone application

ASD: autism spectrum disorder

BTPS: Barriers to Treatment Participation Scale

CBCL: Child Behaviour Checklist

CBT: cognitive behavioural therapy

CENTRAL: The Cochrane Central Register of Controlled Trials

C-GAS: Children's Global Assessment Scale

CGI: Clinical Global Impression Scale

CGI-I: Clinical Global Impressions Scale-Improvement

CGI-S: Clinical Global Impressions Scale-Severity

CINAHL: Cumulative Index of Nursing and Allied Health Literature

COIS-R: Child Obsessive-Compulsive Impact Scale-Revised

CSQ-8: Client Satisfaction Questionnaire-8

CY-BOCS: Children's Yale-Brown Obsessive-Compulsive Scale

DSM: The Diagnostic and Statistical Manual of Mental Disorders

eCBT: enhanced cognitive behavioural therapy

EMBASE: Excerpta Medica database

EMDR: eye movement desensitisation and reprocessing

ERP: exposure and response prevention

FAS: Family Accommodation Scale

GABA: Gamma-aminobutyric acid

GCP: good clinical practice

iCBT: Internet cognitive behavioural therapy

ICD: International Classification of Diseases

ICMJE: International Committee of Medical Journal Editors

ICTRP: International Clinical Trials Registry Platform

ISRCTN: International Standard Randomised Controlled Trial Number

IOS: iPhone operating system

IT: information technology

i-Tools: Internet tools

K-SADS-PL: The Schedule for Affective Disorders and Schizophrenia for School-Age Children –Present and Lifetime Version

LILACS: Latin American and Caribbean Health Sciences Literature

MFQ: Mood and Feelings Questionnaire

NICE: National Institute for Health and Care Excellence, UK

NIMH: National Institute of Mental Health, USA

NNT: number needed to treat

NordLOTS: The Nordic Long-term OCD Treatment Study

OCD: obsessive compulsive disorder

OCS: obsessive compulsive symptoms

PANDAS: Paediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections

PICOS: Population, Intervention, Comparators, Outcomes and Study Design

POTS: The Paediatric Obsessive-Compulsive Disorder Treatment Study

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PTSD: post-traumatic stress disorder

PWA: Parent Working Alliance

RCT: randomized controlled trial

SCARED-R: Screen for Child Anxiety Related Emotional Disorders – Revised

SDQ: Strengths and Difficulties Questionnaire

SSRIs: selective serotonin reuptake inhibitors

SUD: subjective units of distress

tCBT: technology-based cognitive behavioural therapy

TEQ: Treatment Evaluation Questionnaire

UEQ: User Experience Questionnaire

WHO: World Health Organization

Y-BOCS: Yale Brown Obsessive-Compulsive Scale

Chapter 1: Obsessive-compulsive disorder

OCD is characterized by obsessions and/or compulsions. Obsessions are persistent thoughts, urges, or impulses that feel intrusive and unwanted and cause anxiety or distress. These obsessions are triggered by thoughts and ideas, environments, or situations, for example the thought of getting dirty hands from touching a door handle. Compulsions are repetitive behaviours or mental acts that are performed in response to an obsession and the goal is to alleviate the discomfort that is caused by the obsession (APA, 2013).

1.1. Aetiology

The exact causes of OCD are unknown, but both genetic and environmental factors are important.

1.1.2. Genetic Factors

The first evidence that genetic factors played a role in the aetiology of OCD came from family and twin studies. One study found that the risks of OCD and subclinical obsessional symptoms were 4 to 20 times higher when an individual had family members with OCD, compared to controls who did not (Strom et al., 2021). There was a much higher concordance of OCD symptoms among monozygotic twins than dizygotic twins, ranging from 0.29 to 0.58 and these findings provided the earliest assessments of the heritability of OCD (Strom et al., 2021). Sophisticated modern research methods have demonstrated that the genetic contribution to OCD is primarily polygenic, as hundreds or thousands of

genetic variants contribute a very small amount to the overall genetic predisposition to OCD (Davis et al., 2013; Mahjani et al., 2021; Strom et al., 2021). For example, Noh et al. (2017) analysed sequencing data for 608 OCD candidate genes, then prioritized the variants according to their functional and conservation annotations. This process identified four genes with a reproducible variant burden in OCD patients, namely NRXN1, HTR2A, CTTNBP2 and REEP3.

1.1.3. Environmental factors

Surprisingly little is known about the specific aspects of the non-shared environment involved in OCD (Krebs et al., 2019). A systematic review by Brander et al. (2016) concluded that no environmental risk factors for OCD had been compellingly demonstrated. However, the systematic review did indicate some areas of high research interest, such as birth complications, parental age, pregnancy and the postpartum period, infections and stressful life events (Brander et al., 2016).

A more recent study by Krebs et al. (2019) indicated that stressful life events, but not punitive parenting, predicted changes in obsessive-compulsive symptoms (OCS) at a phenotypic level during adolescence. This association existed above and beyond genetic confounding and was consistent with the hypothesis that stressful life events play a causal role in the development of obsessive-compulsive symptoms (Krebs et al., 2019).

1.2. Pathogenesis/pathophysiology

OCD was one of the first mental health disorders to use brain scans to demonstrate abnormal brain activity in specific regions (Baxter et al., 1987).

1.2.1. Structural alliterations of brains

Some neurobiological alterations that are found in OCD patients are also seen in patients with other mental health disorders, such as a smaller hippocampus, a dorsomedial prefrontal cortex and an insular opercular region. Others are more specific to OCD and these include a larger volume basal ganglia, which is most pronounced in older patients and is likely to be related to disease chronicity and/or the long-term effects of medication (Stein et al., 2019). A larger thalamus in unmedicated children with OCD may reflect altered brain maturation (Stein et al., 2019).

1.2.2. Functional alterations of brain

A meta-analysis by Thorsen et al., of 25 functional neuroimaging studies using signal differential mapping demonstrated increased activation in the bilateral amygdala, right putamen, orbitofrontal cortex extending into the anterior cingulate and ventromedial prefrontal cortex, middle temporal cortex, and the left inferior occipital cortex during emotional processing (induced, for example, by exposure to disease-relevant stimuli), particularly in OCD (Thorsen et al., 2018).

1.2.3. Molecular mechanisms

IIt has been suggested that several neurotransmitters are involved in the pathophysiology of OCD, especially serotonin. Other examples are Gamma-aminobutyric acid (GABA) and dopamine (Bandelow et al., 2017). The fact that people with OCD respond selectively to selective serotonin reuptake inhibitors (SSRIs) has drawn attention to the serotonergic system (Bandelow et al., 2017). However, there is still no proof that an underlying serotonin deficit plays a primary causal role in OCD (Bandelow et al., 2017). The dopaminergic system received attention after patients with OCD responded when their SSRIs were augmented with dopamine D2 receptor antagonists (Bandelow et al., 2017). The GABA concentration in the orbitofrontal cortex area of patients with OCD can significantly decrease and the concentration in the anterior cingulate cortex has a tendency to decrease. All of these changes may indicate that there is a relationship between the GABA concentration and the psychopathology of OCD (Li et al., 2019; Zhang et al., 2016).

1.2.4. Inflammatory and immune aspects

Nearly 25 years ago, Swedo et al. (1998) identified a subgroup of 50 patients who experienced an abrupt onset of OCD and tics after infections with group A streptococcus. This was later called Paediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections (PANDAS). It is caused when antibodies that are triggered by the infection react with autoantigens and lead to neuropsychiatric dysfunction. This concept was subsequently extended to include other infections with a similar clinical presentation and is now known as

Paediatric Acute-Onset Neuropsychiatric Syndrome (PANS). A critical shortcoming of the PANDAS model was that it applies to only a small minority of OCD cases (Meyer, 2021). For example, Jaspers-Fayer et al. (2017) found that only 5% of 136 children and adolescents with OCD met the criteria for PANDAS. The relationship between inflammation and OCD was more broadly demonstrated through translocator protein positron emission tomography imaging. This identified greater translocator protein binding in the cortico-striatal-thalamus-cortical circuit in patients with OCD and provided a direct brain measure of an important component of inflammation (Meyer, 2021).

It has already been recognized that *Streptococcus pyogenes* may lead to OCD through PANS and that Toxoplasma gondii also leads to OCD. The mechanisms that determine how these lead to OCD remain unknown, but autoimmunity seems to be involved (Lamothe et al., 2018). Cytokines (i.e. interleukin-6) are molecules that allow communication between immune cells or between immune cells and non-immune cells (Rose-John, 2018). Several studies have reported positive and significant correlations between interleukin-6 and the severity of compulsive behaviours (Lamothe et al., 2018). There is a well-known bi-directional interaction between the gut microbiome and brain activity that affects human behaviour. However, a review by Turna et al. (2016) concluded that there was a possible link between OCD and the microbiome, but the current (2016) literature on this is minimal at best. Two years later Quagliariello et al. (2018) conducted a small study of 38 subjects and observed an imbalance in the gut and oropharyngeal microbiomes of OCD cases. A later study by Turna et al. (2020) reported that an OCD group presented with lower species richness/evenness and lower relative

abundance of three butyrate producing gens (Oscillospira, Odoribacter and Anaerostipes) than a control group without OCD.

1.2.5. Psychological models

Various psychological models have been suggested in an attempt to understand OCD. Röper et al., (1976) studied 12 patients with obsessional checking and found that immediate checking was linked to anxiety reduction. This process, which they called 'spontaneous decay', established the basis for Exposure and Response Prevention (ERP) (Röper & Rachman, 1976). Rachman et al. subsequently carried out a series of experiments and then proposed a model in which they discussed the different roles of the main variables involved in compulsive checking (Rachman, 2002). These were feeling high responsibility, high perceived probability of harm, reduced confidence in memory abilities and the perception that there was no certain end to the threat. The authors discussed the paradoxical effect that can be created by compulsive checking. They stated that the more times a patient carried out safety checks, the more unsure they became about a possible wrongdoing. Later, van den Hout and Kindt (2004) said that repeated checking undermined an individual's trust in their memory and reduced their feeling that they were acting responsibly. Later, exposure therapy was developed, based on the concept of habituation and corrective learning that was proposed by Rachman (1980) 'emotional processing theory' and further developed by Foa and Kozak (1986). During habituation, the patient learns that repeated exposure to feared situations reduces anxiety, even when they do not carry out anxiety-reducing rituals (response prevention). They also learn that the feared consequences do not happen (Foa & Kozak, 1986).

Later research suggested that responses to ERP did not depend on successful habituation, but on fear extinction by inhibitory learning (Craske et al., 2014). Therefore, Craske et al. (2014) suggested a number of strategies for optimizing exposure, based on inhibitory learning techniques. These included for example expectancy violations, deepened and occasional reinforced extinction, removal of safety signals and variability in targeted exposures and settings (Craske et al., 2014).

Figure 1. shows a model that illustrates the vicious cycle of OCD and how OCD develops with a cycle of steps that tend to repeat. Adapted from *Break free from OCD* (Taylor, 2007).

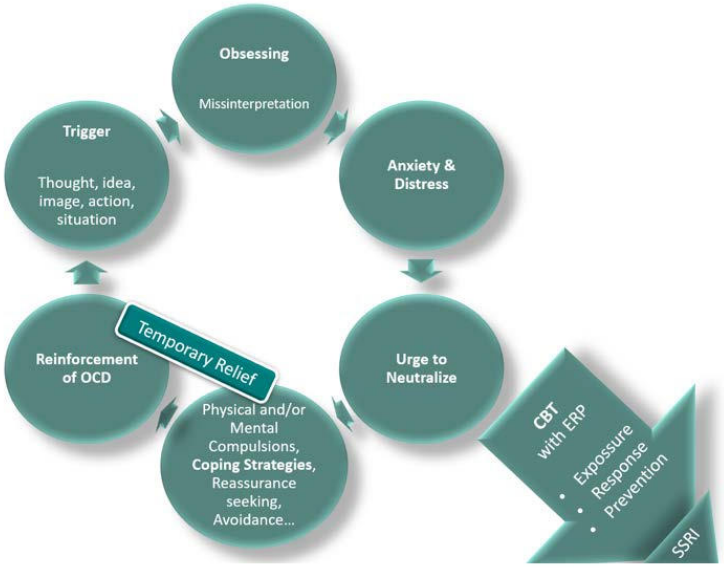


Figure 1. Model for OCD cycle.

OCD starts with a situation, an image or an action that triggers an unpleasant thought in the patient. That thought then leads to anxiety and distress and then becomes an obsession. Because the thought creates an unpleasant feeling, the patient will look for ways to neutralize it by developing behaviours and strategies. The most common ones are seeking reassurance or performing mental or physical avoidance strategies. The patient repeats compulsive behaviour to neutralize the discomfort of the obsessions. These compulsions bring temporally relief but repeating them reinforces the OCD cycle and can create new triggers. Patients often find themselves suffering from more recurrent obsessions and this leads to even more compulsive behaviour. This can have a negative impact on their family, schooling, work, and their whole life.

1.3. Epidemiology

The overall aggregate current, period and lifetime worldwide prevalence rates for OCD are estimated to be 1.1%, 0.8%, and 1.3%, respectively (Fawcett et al., 2020). Their meta-analysis showed that women were 1.6 times more likely to experience OCD than men and that the lifetime prevalence rates were 1.5% for women and 1.0% for men. The authors also noticed that younger adults were more likely to experience OCD in their lifetime than older adults (Fawcett et al., 2020). Epidemiological studies of children and adolescents have reported OCD prevalence rates that have ranged from 0.1% to 4% (Heyman et al., 2003; Mantz & Abbott, 2017). One Swiss study stated that the prevalence of OCD for children was 0.2% (Steinhausen et al., 1998). In the Nordic countries, Atladottir et al. (2015) reported that the cumulative incidence rates for OCD in 20-year-old adults were 0.6% for Denmark and 0.4 % for Finland and Sweden.

Similar figures have been reported by studies carried out in Spain (Canals et al., 2012) and the United States of America (Ruscio et al., 2010).

The difference in the prevalence rates reported by various studies may be due to the different methods used (Torres, Fontenelle, Shavitt, Hoexter, Pittenger, Miguel, et al., 2017). It is likely that the prevalence of OCD has been underreported, because disorders like OCD are often under recognized (Fireman et al., 2001; Uher et al., 2007).

1.4. Onset and clinical presentation

Studies have reported that 76% of people who developed OCD had their first symptoms before 18 years of age and that the average age of onset for OCD in children was 11 years (Chabane et al., 2005; Nestadt et al., 2000; Pauls et al., 1995).

Common obsessions among children and adolescents centre around contamination (69%) and fear of harm (52%) (Flessner et al., 2009). Common compulsions are washing (59%), checking (58%) and repeating compulsions (48%) (Flessner et al., 2009). For example, being obsessed with germs, bacteria, dust, or impurity can lead to carrying out purifying or cleaning rituals to lower anxiety. In serious cases, compulsions can demand so much time that patients spend a big part of their day addressing them, for example, cleaning, sorting and disinfecting their own body or their surroundings. This can reach the point where it impairs their ability to do their job or perform at school. It can also affect other

aspects of their lives, like their families and social lives. Examples of checking compulsions may include the need to double or triple check whether an action has been performed, such as turning off the gas or locking the door. In such cases, patients automatically doubt whether they performed the action or not. This may happen to such a degree that, even after double and triple checking, they still feel anxious and unsure and feel the urge to check again and again.

In general, patients realize the exaggerated nature of their concerns and behaviour. The diagnostic criteria for OCD in The Diagnostic and Statistical Manual of Mental Disorders – 4th Edition (DSM-IV) required a certain level of insight about the exaggerated nature of the obsessions and compulsions (American Psychiatric Association, 2013). The 5th Edition (DSM-5) specifies insight as 'good or fair', 'poor' or 'absent/has delusional beliefs' (American Psychiatric Association, 2013). However, it is not unusual for children to have a limited understanding of their condition, especially the youngest children and those with comorbid mental disorders, such as autism spectrum disorder (ASD). These children may reject the idea that they are displaying obsessions or compulsions as unreasonable or exaggerated (Ruta et al., 2010; Weidle, Christensen, et al., 2014). It is important to recognise this when treating children with poor insight into their OCD symptoms, as they may have a worse prognosis (Storch, Milsom, et al., 2008).

1.5. Impact

OCD often affects many aspects of daily functioning. One study reported that almost half of the children and adolescents who sought treatment for OCD, and their parents, reported significant impairment in important psychosocial domains. These included school, their social lives and family functioning (Piacentini et al., 2003). In severe cases, an individual's symptoms may have such an impact on their social life that seeing friends or attending school become impossible. Some children may try to hide their symptoms, which can lead to avoiding social situations (Flament et al., 1990). Compulsions at school, such as checking, ordering, arranging and repeating rituals or asking for reassurance (Torres, Fontenelle, Shavitt, Hoexter, Pittenger, Miguel, et al., 2017), may not just affect the child's performance. It may also have an impact on their social interactions with peers and teachers (Piacentini et al., 2003; Valderhaug & Ivarsson, 2005). One study reported that children with OCD reported reduced quality of life, compared to the general population. The parents confirmed their children's ratings and also reported substantial impairment in their social functioning (Weidle, Jozefiak, et al., 2014).

OCD often has a significant impact on the whole family, as well as the child's life. Children or adolescents with OCD often need help from their parents, family, and friends to keep up with their rituals. For example, they may repeatedly ask for reassurance or help to perform specific rituals. Three-quarters (75%) of parents reported that their family needed to accommodate this kind of behaviour by a child with OCD (Flessner et al., 2011). Another study reported that this need was inversely related to the children's quality of life (Weidle, Jozefiak, et al., 2014). If

parents refused to accommodate their children's rituals, this could frustrate the child and lead to tension or disruptive behaviour within the family (Lebowitz et al., 2011; Waters & Barrett, 2000). However, gradually reducing how much OCD behaviour is accommodated can help children to recognize the severity of their OCD symptoms. This can help them to gradually break with their rituals, rather than helping them to maintain them (Lebowitz et al., 2011; Waters & Barrett, 2000).

1.6. Classifications of OCD: DSM-IV, DSM-5, ICD-10 and ICD-11

OCD is classified under anxiety disorders in the International Classification of Diseases 10th edition (ICD-10) (WHO, 1992) and the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (Widiger et al., 1997). In ICD-10, OCD is described as F42 obsessive-compulsive disorder with the following subgroups: F42.0 predominantly obsessional thoughts or ruminations, F42.1 predominately compulsive acts (obsessional rituals) and F42.2 mixed obsessional thoughts and acts. According to ICD-10, the obsessions or compulsions, or both, should be present on most days for a period of at least two weeks and to such a degree that the symptoms cause distress or interfere with social or individual functioning. The DSM-IV specifies that obsessions or compulsions must occupy more than an hour a day.

In DMS-5, OCD is included in an own chapter about obsessive-compulsive and related disorders (APA, 2013; Hirschtritt et al., 2017). Even though anxiety is common in patients with OCD, we now understand that it is a secondary manifestation, rather

than a core component of OCD (Leckman et al., 2010; Van Ameringen et al., 2014).

ICD-11 was officially approved by the World Health Organization (WHO) Health Assembly in 2019 (WHO, 2019). ICD-11 closely follows DSM-5 and describes OCD in a separate chapter. It is described as 6B20, which is obsessive-compulsive and related disorders. The related disorders in ICD-11 are: 6B21 Body Dysmorphic Disorder, 6B22 Olfactory Reference Disorder, 6B23 Hypochondriasis (Health Anxiety Disorder), 6B24 Hoarding Disorder, 6B25 Body-Focused Repetitive Behaviour Disorders (6B25.0 Trichotillomania (Hair Pulling Disorder) and 6B25.1 Excoriation (Skin Picking Disorder) (WHO, 2019). ICD-11 specifies similar diagnostic criteria to previous ICD versions and DSM-5. It states that either obsessions or compulsions must be present for a diagnosis of OCD and that they must be distressing, cause impairment or be time consuming, for more than an hour a day. ICD-11 further specifies that they cannot be explained better by other medical conditions or drug abuse (WHO, 2019).

1.7. Assessment

1.7.1. Assessment principles

Patients with suspected OCD should be carefully examined and this includes their present mental status and a detailed history of their OCD symptoms. Clinical OCD questionnaires such as the CY-BOCS are helpful to describe OCD symptoms and assessing their severity (Goodman et al., 1991; Storch et al., 2004). The CY-BOCS is considered to be the gold standard tool for measuring the severity of paediatric OCD (Lewin et al., 2014).

When clinicians are assessing ADD patients with OCS, they must ask about disturbing invasive thoughts, compulsively repeated rituals and behaviours and situations, things or locations the patient may be avoiding (Deacon & Abramowitz, 2005). It is recommended that this initial assessment should include the functional status of the child and family in terms of impairment and quality of life (Piacentini, 2021). The Child OCD Impact Scale (COIS) (Piacentini et al., 2007) can be used to assess the impact of the OCD symptoms on the child's psychosocial functioning. The overall mental health assessment could be complemented by The Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime Version (K-SADS-PL) (Ambrosini, 2000). A physical examination is also required, to assess the child's physical status and rule out potential somatic causes.

1.7.2. Differential diagnoses

Anxiety disorders (generalized anxiety disorder, panic disorder, and different phobias), depressive disorder, eating disorders, bipolar affective disorder, psychosis, tic disorders, substance use disorders, hoarding disorder, body dysmorphic disorder, trichotillomania, skin picking disorders, paraphilia, gambling disorder, autism spectrum disorder and personality disorders must be ruled out (or diagnosed as comorbid disorder) (Nazeer et al., 2020).

1.7.3. Comorbidities

A comorbidity is the co-occurrence of two or more disorders in the same patient (Caron & Rutter, 1991). The most common comorbidities in children with OCD are anxiety disorders, attention deficit hyperactivity disorder (ADHD), mood disorders, Tourette Syndrome, ASD and oppositional defiance disorder (Storch, Merlo, et al., 2008; Torres, Fontenelle, Shavitt, Hoexter, Pittenger, & Miguel, 2017; Wu et al., 2019). These comorbidities could be explained by varying levels of overlapping genetic and neurodevelopmental factors (Leckman et al., 2010; Van Ameringen et al., 2014).

Ivarsson et al. (2008) reported that up to 80% of children with OCD had at least one comorbid disorder. A more recent study (Højgaard et al., 2018) found three clinically meaningful comorbidity classes. The first class was linked to neurodevelopmental disorders, such as ADHD and tic disorders. The second class was linked to comorbid anxiety-related disorders and the third comprised patients that did not show any comorbidities.

Subclinical autistic symptoms were reported in 10-17% of paediatric OCD patients who were not diagnosed with comorbid ASD (Arildskov et al., 2015; Weidle et al., 2012). Other studies found that 8-25% of children and adolescents treated for OCD fulfilled the diagnostic criteria for ASD (Ivarsson & Melin, 2008; Martin et al., 2020). Epidemiologic studies have stated that the prevalence of OCD in children with ASD ranged from 8 to 37% (Leyfer et al., 2006; Simonoff et al., 2008). A meta-analysis of prevalence studies found a 17% prevalence of OCD in individuals with ASD who were under 18 years of age (van

Steensel et al., 2011). However, the large study by Martin et al. (2020), which is mentioned above, found that only 5% of patients with ASD also had a diagnosis of OCD.

1.8. Treatment

Fifty years ago, OCD was considered to be an intractable mental health disorder with a poor prognosis. Psychoanalysis was the standard treatment for OCD until the 1970s. In 1967, a Spanish psychiatrist, Juan José López Ibor found that clomipramine had a positive effect on OCD (Fernández-Córdoba & Lopez-Ibor Alino, 1967). Effective psychological treatments were developed in parallel to the discovery of medical treatment for OCD. These were CBT and ERP, which was originally based on behaviourist psychology. In the late 1970s ERP was expanded by the addition of cognitive concepts and procedures and merged into CBT (Rachman, 2015). CBT is a general concept for treatment methods that aim to introduce changes in dysfunctional thinking and behaviour.

The most effective treatments for OCD at the moment are CBT and/or SSRIs (Fineberg et al., 2020).

1.8.1. CBT

1.8.1.1 Individual CBT

CBT with ERP is the first-line treatment for OCD (NICE, 2005). During ERP, patients are exposed to triggering stimuli while they prevent a compulsive response. This process may lead to habituation to the stimuli and reduce the frequency and intensity of their obsessions.

Other models, like Inhibitory Learning Theory, suggest that patients learn about the safety of the presented stimuli during the ERP process and this, in turn, inhibits the original fear (Jacoby & Abramowitz, 2016). The UK National Institute for Health and Care Excellence (NICE) recommends that children and young people with OCD should be offered CBT with ERP as first-line treatment and that this should involve their family and carers (NICE, 2005). Similar guidelines have also been published in Sweden (Health & Welfare, 2016) and Denmark (Sundhedsstyrelsen, 2016).

1.8.1.2. Group CBT

A systematic review and meta-analysis reported very large effect sizes for comparisons between CBT with waiting-list (1.31), and placebo conditions (1.33). In contrast, the comparisons between individual and group treatment (0.17), and exposure and response prevention versus cognitive therapy (0.07), were small and non-significant. This study showed that there was no significant difference between individual and group CBT. However the individual CBT was more expensive than group CBT (Öst et al., 2015).

1.8.1.3. Intensive CBT treatments

Farrell et al., provided strong evidential support for intensive, time-limited approaches to ERP-based CBT for children and youths with OCD. Overall, there were significant reductions across time on most of the measures, except self-

reported anxiety. The majority of the sample (80%) were considered to have made reliable improvements and they met the criteria for clinically significant change. After treatment, 60% were in remission and this had increased to 70% at the six-month follow up. These findings provide strong support for intensive, time-limited approaches to ERP-based CBT for children and youths with OCD (Farrell et al., 2016).

In Norway, an intensive ERP treatment model for adults, which was provided over four consecutive days (Hansen et al., 2018), resulted in remission rates of nearly 70% at the six-month follow up. Long-term outcomes were measured after four years and 72% of the 77 adults had recovered from OCD.

This Norwegian treatment model was also adapted for children and adolescents. Treatment was delivered to 2–4 patients and their parents in a group setting over four consecutive days and this was followed by a three-week period of self-administered ERP (Riise et al., 2018). The treatment included intensive therapist-assisted individual daytime exposure in the home environment for two whole days, followed up by texts or phone calls in the evening. There were also regular group meetings, where patients received peer support. The study, which comprised 41 patients aged 11–18 years, showed that remission was between 80-90% post-treatment and 77-73% at the six-month follow up (Riise et al., 2018). However, this kind of intensive approach has its limitations, as not all children have the motivation for, or are ready for, such demanding, intense treatment. Children are often brought to treatment by their parents and their motivations can differ. In addition, children may have less insight than adults about the impact that OCD has on their lives and less tolerance for unpleasant feelings during the exposure tasks.

1.8.2. Medication

Medication is indicated for children and young people when symptoms are more severe, CBT has failed, or skilled CBT is unavailable. It is also indicated when there is a comorbid disorder, such as depression, that may respond to medication, or when the parents or clinicians find an indication that the earlier introduction of medicine is clinically indicated (Fineberg et al., 2020). RCTs involving youths have shown that SSRIs have been well tolerated and effective (Geller et al., 2004; Skarphedinsson et al., 2015).

Potential adverse effects from medication may have an impact on the child's wellbeing (Reid et al., 2015). Studies have shown that there was a higher risk of relapse after they discontinued medication and the potential side-effects for long-term use were unknown (Geller & March, 2012; Storch, Larson, et al., 2010).

1.8.3. CBT versus medication

A meta-analysis by McGuire et al. (2015) found larger treatment effects for CBT (g=1.21) than for SSRIs. Olatunji et al. (2013) analysed 16 RCTs with 756 subjects and concluded that CBT was efficacious in treating OCD and should clearly be the first-line treatment for children and adults. A meta-analysis by Ivarsson et al. (2015) concluded that CBT had as larger effect size than the use of SSRIs for paediatric OCD. A systematic review by Uhre et al. (2020) which comprised nine trials with 645 subjects, concluded that CBT and SSRIs had comparable beneficial effects on the symptom severity of OCD patients. However

sequential analysis of the trials suggested that the results may have been a random finding, due to lack of power or multiple testing (Uhre et al., 2020).

The Paediatric Obsessive Compulsive Treatment Study (POTS) showed that, on average, a combination of CBT and SSRI was superior to just CBT (POTS, 2004). However, when Asbahr et al. (2005) compared group CBT and SSRI interventions, both groups had significant symptom reductions after treatment. At the nine-month follow up, patients who had received the group CBT showed a significantly lower rate of symptoms relapse than those in the SSRI group (Asbahr et al., 2005). POTS II (Franklin et al., 2011) found that combining CBT and SSRIs led to a significantly greater response rate than just medication. However, a study by Storch et al. (2013) found no advantage from the combination of CBT and SSRI compared to placebo. The differences in the results of these studies may be explained by the fact that the Storch et al. (2013) trial treatment was conducted by specialized OCD therapists, which may have had an impact on the results. The authors argued that the combination of CBT and SSRIs may be the most beneficial when specific clinical features or severe symptoms inhibit the patient's engagement with CBT (Storch et al., 2013).

1.8.4. Treatment initiatives in Norway

In 2011, the Norwegian Health authorities decided that by 2016, all patients with OCD should have access to evidence-based psychological treatment, delivered by specialized OCD teams. Thirty OCD-teams were established, 15 for adults and 15 for children, to ensure treatment was available across the whole country and that the uptake areas would be large enough. A large-scale training

programme was organized for the Norwegian therapists working in the OCD teams and this included internationally recognized OCD experts, J. Abramowitz, M. Franklin and J. Himle (Kvale & Hansen, 2014). This nation-wide implementation plan and training programme for therapists was supported by the country's National Health authorities. In addition of the brief intensive treatments described above, it may have contributed to making OCD treatment available across the whole country.

1.8.5. Barriers to treatment

There are a number of barriers to OCD treatment, for both parents and children, that may prevent families from seeking help (Marques et al., 2010). These include shame, stigma, and beliefs about OCD treatment, such as doubts about being able to commit to exposure exercises and low expectations due to poor treatment experiences in the past. Individuals with OCD have also reported barriers such as treatment costs (57%), insurance coverage (38%) and how much time the treatment would take (31%) (Marques et al., 2010).

CBT has been well-established as the first-line treatment for children with OCD. However studies have reported that the greatest barriers to dissemination were the limited availability of services, including geographic barriers, the lack of appropriate training for therapists and the poor delivery of CBT (Shafran et al., 2009; Wolters et al., 2017). A substantial proportion of patients reported receiving other interventions than ERP for their OCD, which ignored the guidelines treating OCD. These were talk therapy, psychodynamic or eye movement desensitisation

and reprocessing (EMDR) (Marques et al., 2010; Stobie et al., 2007). In addition, recognising and treating OCD is often delayed and this results in more comorbidities and higher health-related economic burdens (Fineberg et al., 2013; Hollander et al., 1998; WHO, 2013).

Modern technology could be one way to overcome at least some of these limitations.

1.9. Prognosis

If OCD is left untreated, it has a chronic course in around 40-60% of those affected (Micali et al., 2010; Selles et al., 2018; Skoog & Skoog, 1999; Stewart et al., 2006). The remission rates in paediatric OCD studies have ranged from 32–79% depending on the methodology and type of the sample studied, for example epidemiological or clinical (Mancebo et al., 2014). Remission is more likely among youths than adults with OCD (Mancebo et al., 2014).

The NordLOTS multicentre trial, which was carried out in three Scandinavian countries, found that 73% of the 269 patients had responded well to treatment, defined as a total CY-BOCS total score of ≤ 15 (Torp et al., 2015). The majority (92%) had maintained their treatment gains at the one-year follow up (Højgaard et al., 2017). Furthermore, three years after treatment 90% of the participants were classed as responders and 73% were in clinical remission, with a total CY-BOCS score of ≤10 (Melin, Skarphedinsson, Thomsen, Weidle, Torp, Valderhaug, Højgaard, et al., 2020).

Chapter 2: iCBT

The use of Internet-based CBT, often called iCBT, has the potential to improve both the access to, and the quality of treatment. iCBT is also known as online CBT, electronic technology CBT (e-tCBT), web CBT, computerized CBT (cCBT), digital CBT and cyber CBT (tCBT) (Andersson et al., 2016). iCBT can include a range of technologies and different levels of involvement by therapists. These include smartphones, telephones, webcams, tablets, and/or computers using e-mails, sms-texts, blogs, social media, mobile applications, videos, instant messaging and/or podcasts (Wolters et al., 2017).

2.1. The rapid growth of the Internet

In 2021, the number of mobile devices operating worldwide was 15.0 billion, compared to 14.0 billion in 2020. The number of mobile devices is expected to reach 18.2 billion by 2025, which would be an increase of 4.2 billion on 2020 (Statista, 2021). In April 2022, there were five billion Internet users worldwide, which equated to 63% of the global population and 4.6 billion of those used social media (Statista, 2021).

The vast majority of the world's Internet users (92.4%) use a mobile phone to go online, at least some of the time. Mobile phones now account for more than half of online time and more than half of the world's web traffic (Datareportal, 2022).

This expansion has defied all expectations, even in poorer areas like Sub-Saharan Africa, where 24.4% of the population had access to the Internet in 2018 and 77.0% had a mobile subscription (ITU, 2018).

These days, the Internet plays a vital role in the lives of children and adolescents, who use it daily for both schoolwork and communicating with peers (Ólafsson et al., 2014). A 2020 UK survey of 2,167 children and adolescents from 5-16 years of age showed that 90% had their own smart device by the age of 11 and almost 100% had a smartphone in secondary school (Anonymous, 2010; Childwise.; Onnela, 2021). Another UK longitudinal study examined associations between Internet use and mental health among 1,431 young people aged 18-21 years and found that they spent 14 hours online per week (Mars et al., 2020). Females reported high levels of Internet use, in terms of hours online, and had an increased risk of depression at follow up: highest tertile versus lowest tertile OR = 1.41, 95% CI 0.90 to 2.20. Males with high levels of Internet use had an increased risk for self-harm: highest tertile versus lowest tertile OR = 2.53, 95% CI 0.93 to 6.90 (Mars et al., 2020).

2.2. ‘The Wild-Wild e-West’

As of April 2022, there were 52,565 healthcare and medical apps available on the Google Play Store. From 1 January 2020 to 31 December 2021, the number of healthcare and medical apps available to Android users via the Google Play Store continued to grow, reaching more than 65,300 during the last quarter of 2021 (Statista, 2022). (iOS) users also kept growing and by the first quarter of 2021 it had reached its peak of almost 54,000 apps (Statista, 2022).

On 26 June 2021, new European Union regulations were introduced to increase security and regulatory certainty. For example, these provided harmonised rules on drug device combination products, tissue engineering, nanoscience, personalised medicine, substance-based devices and genetic tests. They also took into account the latest developments in the sector, such as medical software, apps and cybersecurity (Parliament, 2017). In addition, a number of directives became valid in 2018 in the European Economic Area countries: Iceland, Liechtenstein and Norway (Mondschein & Monda, 2019). These were: Directive 95/46/EU, 200/31/EC and 2002/58/EC, which include the General Data Protection Regulation (Raposo, 2016).

There has clearly been a need for better regulation. For example, in 2015 the UK National Health Service launched the online Health Apps Library (Firth et al., 2016). This library listed 14 apps as ‘safe and trusted’ for treating mental health issues, but only four of these were scientifically supported when they were reviewed (Leigh & Flatt, 2015). Huckvale et al analysed the apps on the Health Apps Library and found that two-thirds did not encrypt the user’s data and 35 apps transmitted personal identification data to third parties (Huckvale et al., 2015).

Following these revelations, the online library was closed down. It was relaunched in 2017, with certified mobile health apps, but was then decommissioned in December 2021 (NHS, 2021).

Sucala et al. (2017) found that only 3.5% of the 52 apps that were available from iTunes and Google Play to treat anxiety disorders had been scientifically

evaluated. Another review of 361 iOS apps for anxiety disorders reported that the majority (87%) did not employ evidence-based knowledge (Kertz et al., 2017).

As Leigh and Flatt (2015) had previously stated, there was 'high availability but low evidence base' when it came to e-health and health apps.

The Norwegian Government launched a quality-assured health tools apps library in 2020, which offered tools that satisfied 'the necessary requirements for health professional quality, privacy and security' (Helsenorge.no, 2022).

2.3. iCBT for mental health disorders

In their meta-analysis on the Effectiveness of Youth Psychotherapy Delivered Remotely, Venturo-Conerly et al. (2021) analysed RCTs on psychotherapy for anxiety in youth. These included OCD and trauma, depression, ADHD and conduct problems. Remote therapeutic contact was used in all cases (Venturo-Conerly et al., 2021). They identified 37 papers, published from 1988 to 2020, and these comprised 43 comparisons of treatment and control groups.

The pooled effect size was 0.47 (95% confidence interval [CI: 0.26, 0.67], p, 0.001) at posttreatment, and 0.44 (95%CI [0.12, 0.76], p,.05) at follow-up comparable to effects reported in meta-analyses of in-person youth psychotherapy. Effects were significantly (a) larger for remote psychotherapies supported by therapeutic provider contact (0.64) than for those accessed by youths, with only logistical support (0.22), (b) larger for treatments with phone contact (0.65) than for those without (0.25), (c) larger for treatment of anxiety (including OCD) (0.62) and conduct problems (0.78) than ADHD (–0.03), and (d) smaller for therapies involving attention/working memory training (–0.18) than for those without (0.60) (Venturo-Conerly et al., 2021).

A systematic review and meta-analysis on iCBT for children and adolescents with internalising disorders included 58 studies with 4,618 subjects (Wergeland et al., 2021). The results showed that the effect of iCBT was equivalent to the effect of traditional face-to-face interventions with large effect sizes post-treatment (g = 1.28–2.54) and at follow up (g = 1.72–3.36). Remission rates ranged from 50.7% to 77.4% post-treatment and 53.5% to 83.3% at follow-up. Pennant et al. (2015) systematically reviewed the evidence for computerised anxiety and depression interventions in children and young people aged 5–25 years old in the general population and identified 27 relevant RCTs. They found small positive effects for anxiety (SMD −0.15, 95% CI −0.26 to −0.03 in 1,273 subjects) and depression (SMD −0.15, 95% CI −0.26 to −0.03 in 1,280 subjects). There was uncertainty around the effectiveness of cCBT in children aged 5–11 years.

Christ et al. (2020) carried out a meta-analysis on anxiety and depression in children and young adults aged 12 to 25 years of age. When the subjects were compared with controls who did not receive the intervention, cCBT yielded small to medium post-treatment pooled effect sizes for depressive symptoms (g=0.51, 95% CI 0.30 to 0.72, number needed to treat (NNT) = 3.55) and anxiety symptoms (g=0.44, 95% CI 0.23 to 0.65, number needed to treat = 4.10). cCBT yielded effects similar to those reported for active treatment controls, with regard to anxiety symptoms (g=0.04, 95% CI -0.23 to 0.31). For depressive symptoms, the non-significant pooled effect size favoured the active treatment controls (g= -

0.70, 95% CI -1.51 to 0.11, p=0.09), but heterogeneity was very high (I^2=90.63%) (Christ et al., 2020).

Overall, previous research has indicated promising results for iCBT, but better designs and larger studies are needed to confirm the results.

2.4. iCBT for adults with OCD

The first meta-analysis on technology-delivered CBT also called (T-CBT) for adults with OCD was published in 2015 and covered eight trials with 420 participants (Dettore et al., 2015). The authors reported that T-CBT was superior to the control conditions for OCD symptom outcomes post-treatment (Cohen's d=0.82, 99% CI 0.55 to 1.08, p=0.001), but not for comorbid depression (Cohen's d=0.33, 99% CI - 0.01 to 0.67, p=0.020). In addition, there was a high risk of bias in two trials. Greist et al. (2002) compared iCBT to systematic relaxation and clinician-guided behaviour therapy. The effect sizes for iCBT, clinician-guided CBT and relaxation were 0.84, 1.22 and 0.35 respectively. This indicated that iCBT was effective, but that clinician-guided behaviour therapy was even more effective. Systematic relaxation was ineffective. The within-group effect size (1.64) in a Korean study of iCBT with minimum therapist involvement (n=27) was quite high (Seol et al., 2016), compared with the effect size (0.8 in iCBT) reported by Greist et al. (2002). Andersson et al., published a randomized controlled trial, in which 101 adults with OCD were randomly assigned to either iCBT or a control group (consisting of online supportive therapy) for 10 weeks.

Both groups showed significant improvements in their OCD symptoms, but the iCBT group experienced larger improvements than the controls on the Yale Brown Obsessive-Compulsive Scale (Y-BOCS), with a significant between-group effect size (Cohen's *d*) of 1.12 (95% CI 0.69 to 1.53) post-treatment. The proportion of participants who showed clinically significant improvements was 60% (95% CI 46 to 72) in the iCBT group, compared to 6% (95% CI 1 to 17) in the control group. The results were sustained at follow up (Andersson et al., 2012).

Patel et al. (2018) replicated the Swedish program by Andersson et al. (2012) in New York. They showed that OCD ($F = 28.12$, $df = 2, 49$, $p < 0.001$), depressive symptoms ($F = 5.87$, $df = 2, 48$, $p < 0.001$) and quality of life ($F = 12.34$, $df = 2, 48$, $p < 0.001$) improved significantly in patients with moderate to severe OCD. The same research group carried out an open trial (Wheaton et al.2021), to try to identify predictors of iCBT outcomes and determine who was most likely to benefit from iCBT. The results showed that higher Y-BOCS scores at baseline, pre-treatment avoidance and having received previous face-to-face CBT were correlated with worse outcomes (Wheaton et al., 2021).

Wootton et al. (2013) carried out a trial with 35 adults with OCD, who were randomized to bibliotherapy CBT (bCBT), iCBT and a wait list control group. The 15 patients in the iCBT group and the 20 patients in the bCBT groups improved, but the iCBT group demonstrated a larger effect size: bCBT 1.05 (0.32–1.81) versus iCBT 2.00 (0.97–2.00).

In another study by Wootton et al. (2019) 190 patients were randomized to either self-guided iCBT or a wait list control group. The between-group effect size post-treatment was large on the self-report version of the Yale-Brown Obsessive-

Compulsive Scale (Cohen's d=1.05, 95% CI 0.89 to1.21). This indicated that self-guided iCBT may be a viable treatment option for some individuals with OCD symptoms (Wootton et al., 2019).

Kyrios et al. (2018) randomized 179 adults with OCD, stratified by gender, to either iCBT or a control group that received Internet-delivered relaxation. The iCBT group showed reduced symptom severity (p=0.001). Post-treatment: Cohen's d for the iCBT group was 1.05 (95% CI 0.72 to 1.37) and for the relaxation group it was 0.48 (95% CI 0.22 to 0.73) (Kyrios et al., 2018). The novelty of this study was the use of a digital control condition, which avoided potential confounding variables. The digital control condition consisted of therapist-assisted, Internet-based progressive relaxation therapy, which comprised psychoeducation and relaxation techniques to manage OCD-related anxiety. However, it did not incorporate ERP or other CBT elements.

2.5. iCBT for OCD in children

The first article in this thesis was a systematic review on the acceptability, feasibility, and effectiveness of iCBT for paediatric OCD and it included papers from 1987 to March 2018 (Babiano-Espinosa et al., 2019). Six studies with 96 participants were eligible (Comer et al., 2014; Comer et al., 2017; Farrell et al., 2016; Lenhard et al., 2014; Lenhard. et al., 2017; Storch et al., 2011). The review included three randomized controlled trials by Comer et al. (2017), Lenhard. et al. (2017) and Storch et al. (2011), one open trial by Lenhard et al. (2014), one

single case non-concurrent multiple baseline design by Farrell et al. (2016), and one case series by Comer et al. (2014).

Comer et al. (2017) compared 14 weeks of family-based iCBT with face-to-face CBT. The iCBT intervention included video-teleconferencing and interactive psycho-educative computer games. An American study by Storch et al. (2011) compared CBT delivered via video-teleconferencing with a wait list control using the POTS protocol (POTS, 2004). This included webcam sessions and emails with homework instructions. In Australia, Farrell et al. (2016) provided a six-week intensive treatment programme that combined iCBT and face-to-face CBT. The intervention included a one-hour traditional face-to-face psychoeducation session, two face-to-face ERP sessions for two weeks, followed by 45-minute video conference sessions for maintenance once a week for three weeks.

The therapist involvement in these six studies (Comer et al., 2014; Comer et al., 2017; Farrell et al., 2016; Lenhard et al., 2014; Lenhard. et al., 2017; Storch et al., 2011) varied from occasional indirect contact via messages or by phone (Lenhard et al., 2014; Lenhard. et al., 2017) to substantial therapist contact via frequent video-teleconferencing (Storch et al., 2011). Parents were actively involved in the treatment processes in all the studies. The treatment drop-out rates ranged from zero (Comer et al., 2014; Farrell et al., 2016) to two (6.4%) (Storch et al., 2011). Five studies reported on acceptability, and it was high in all 5 studies (Comer et al., 2014; Comer et al., 2017; Lenhard et al., 2014; Lenhard. et al., 2017; Storch et al., 2011). Storch et al. (2011) and Farrell et al. (2016) reported symptom reductions of 56.1% and 49%, respectively, post-treatment. Lenhard et al. (2014) and Lenhard. et al. (2017) reported an average reduction of 41% and 26% in the CY-BOCS scores following iCBT in their open trial and

randomized controlled trial, respectively. Comer et al., reported a 35% and 28% average reduction in CY-BOCS scores post-treatment in their randomized controlled trial (Comer et al., 2017) and case series (Comer et al., 2014), respectively. At the six-month follow up, they reported significant improvements in the iCBT group from pre-treatment to post-treatment (Comer et al., 2017).

The study by Rees et al. (2016), examined an online self-help programme with 132 participants aged 12-18. The diagnosis of OCD was not confirmed by a clinician and the OCD symptoms were assessed online with the Youth Online Diagnostic Assessment (YODA). The study was not eligible for our systematic review because the diagnostic procedure was based on self-rated subclinical OCD. The authors found that 97 participants (73.5%) met the criteria for OCD using the YODA. After treatment, the participants showed significant reductions in OCD symptoms ($p<0.001$) and severity ($p<0.001$), measured by the self-report version of the Children's Florida Obsessive-Compulsive Inventory (C-FOCI) (Rees et al., 2016).

New, relevant studies have been published since our systematic review was carried out. In Sweden, Lenhard et al., delivered a 12-session iCBT intervention via an Internet platform, with psychoeducational texts, films, animations and exercises. This treatment was also used in their previous studies in 2014 and 2017 (Lenhard, Andersson, et al., 2017; Lenhard et al., 2014) that were described in our systematic review (Babiano-Espinosa et al., 2019). During the treatment period, patients had on-demand contact with a therapist through messages and occasional telephone calls. Lenhard et al. (2020) measured long term outcomes

(Lenhard et al., 2020) in 61 subjects and this showed that treatment responders and remitters remained stable from post-treatment to the three-month follow up and that symptoms decreased from the three-month to 12-month follow ups ($\beta = 3.99$, $t = 4.92$, $p < 0.0001$). This study suggested that the gains that youths derived from ICBT were not just maintained in the long term, but further improvements continued to occur during follow up. The same iCBT programme was replicated with younger-children from 7 to 11 years of age (Aspvall et al., 2018). In the initial pilot study with 11 subjects, the reduction in OCD symptoms post-treatment had large within-group effect size on the CY-BOCS total scores (Cohen's d = 1.86, 95% CI 0.83 to 2.86). The results were maintained at the three-month follow up. The children and parents reported high satisfaction with the intervention. Later, the same authors conducted a two-site randomized non-inferiority trial of iCBT with 152 children that used a stepped care approach. This approach was as efficacious as face-to-face treatment, with an estimated mean difference of 0.91 CY-BOCS points (95% CI -1.46 to 3.28, p = 0.45). The response rates in both groups was 68%. The cost for the iCBT healthcare provider was significantly lower than face-to-face CBT (Aspvall, 2020; Aspvall et al., 2021). Hollmann et al. (2021) published a feasibility study on iCBT for nine children with OCD. They reported that the CY-BOCS total score decreased by 34% (8.7 points) post-treatment. Two of the nine patients achieved remission and four responded to treatment (Hollmann et al., 2021). An iCBT study for youths with both OCD and ASD (Wickberg et al., 2022) found that 61% of participants responded to iCBT and 50% were in remission at the three-month follow-up point. These findings were compared with benchmark data from a specialist clinic that regularly treats individuals with OCD and ASD. This showed that face-to-face

CBT produced larger effects than iCBT (Cohen's d = 2.69 versus 1.33) but required considerably more resources. They concluded that iCBT could be successfully adapted to treat OCD in youths with ASD (Wickberg et al., 2022).

2.6. Contribution of this thesis to current knowledge

Internet technology and smartphones can be powerful tools for reducing barriers to the delivery of traditional CBT and may have a profound influence on how this treatment is provided for children and adolescents with OCD. The first step in this thesis was to carry out a systematic review to explore and describe state-of-the-art on iCBT for paediatric OCD (Babiano-Espinosa et al., 2019). This review summarized the available research on the topic and adhered to strict scientific guidelines and reproducible methods. There have been many studies published on iCBT for adults with OCD (Dettore et al., 2015; Ferreri et al., 2019; Hoppen et al., 2021) and many studies published on iCBT for children and adolescents for disorders other than OCD. However, we were only able to identify six studies on iCBT for paediatric OCD (Comer et al., 2014; Comer et al., 2017; Farrell et al., 2016; Lenhard et al., 2014; Lenhard. et al., 2017; Storch et al., 2011). We concluded that, although their results were generally promising, the evidence base for iCBT was still limited and more research was needed.

The next step was to develop an innovative treatment package for children and adolescents with OCD, which aimed to address challenges such as accessibility and the availability of traditional face-to-face CBT. This eCBT package enhanced

traditional CBT by offering therapist-guided exposure exercises that were conducted at home via a webcam. These were provided in addition to face-to-face sessions and an app that supported and monitored treatment. The components of this package are described in detail in Paper 2 (Wolters et al., 2020).

The third step was to evaluate the acceptability and feasibility of this programme for 25 young patients aged 8 to 17 years with OCD (Babiano-Espinosa, Wolters, et al., 2021). Our results showed positive patient feedback on the acceptability and feasibility of the programme. The final part of this PhD thesis consisted of a first evaluation of the effectiveness of this intervention compared to standard CBT (Babiano-Espinosa, Skarphedinsson, et al., 2021). The benchmark that we used was historical outcome data from NordLOTS, which is the largest study to date on the effectiveness of CBT for paediatric OCD. We concluded that eCBT for OCD was non-inferior to the traditional face-to-face CBT provided by NordLOTS.

Chapter 3: eCBT for paediatric OCD

Developmental stages of the eCBT programme for paediatric OCD:

A. Carried out a systematic review on the evidence for iCBT for children with OCD (Paper 1).

B. Created the eCBT concept and developed it for paediatric OCD (Paper 2).

C. Developed the enhanced CBT concept for paediatric OCD. Five components were integrated into the eCBT treatment process: videoconferencing sessions, face-to-face sessions, an app system that aimed to support the treatment structure with a psychoeducation tool and frequent online ratings, which allow direct feedback to the patient.

D. Developed the tools. This was developed by RKBU Midt Norge, NTNU and Bouvet, the largest IT development company in Central Norway, and Kindergarten created the video.

E. Evaluated the acceptability and feasibility of eCBT for paediatric OCD (Paper 3).

F. Compared eCBT for paediatric OCD with traditional face-to-face CBT (NordLOTS) (Paper 4).

In addition to the four published peer-reviewed papers, the findings were presented at institutional, local, national and international levels. Institutional was

research meetings at the Regional knowledge centre for children and adolescents (RKBU) 2018 and 2019, and at the St. Olav's Hospital Mental Health Day meeting in 2021. Local was TEDx Trondheim 2021. National was the Regional Forskningskonferanse 2019 in Kristiansund. International was The International Association for Child and Adolescent Psychiatry and Allied Professions' (IACAPAP) World Congress 2018 in Prague, Czech Republic.

3.1. Research questions

a) What is the current state-of-the-art of Internet interventions for paediatric OCD?

b) Is eCBT feasible for paediatric OCD? Will patients follow the treatment or drop out? Will therapists adhere to the protocol? Are there any other barriers to implementation?

c) Is eCBT for paediatric OCD acceptable? Will participants experience the programme as helpful and attractive?

d) Is eCBT for paediatric OCD effective and non-inferior to traditional face-to-face CBT?

3.2. Methods

3.2.1. Paper 1: Methods for the systematic review (Paper 1)

3.2.1.1. Research Strategy

See Appendix (p.177)

3.2.1.2 Inclusion and exclusion criteria

The inclusion and exclusion criteria were based on the Population, Intervention, Comparators, Outcomes and Study Design 'PICOS' approach to reviewing empirical studies (Beller et al., 2013):

Inclusion criteria

a) Population

Children and adolescents from 4 to 18 years of age were included. Papers in which patients had a primary diagnosis of OCD diagnosed by a psychologist or psychiatrist according to DSM or ICD criteria were accepted. All treatment settings and any cultural background, ethnicity and sex were accepted.

b) Intervention

We accepted any CBT approach with Internet technology components and no restrictions were placed on therapist involvement or additional treatment.

c) Comparators

We accepted studies with and without comparators.

d) Outcomes

The outcomes were acceptability, feasibility and/or efficacy.

e) Study design

The systematic review included randomized controlled trials, blind trials, non-blind trials, adaptive clinical trials, non-randomized trials, interrupted time series

designs, cohort studies, case-control studies and cross-sectional study. The studies had to be published in English.

Exclusion criteria

a) Population

Studies for adults were excluded. We also excluded studies in which the OCD diagnosis was not determined by a qualified specialist, namely a psychologist or psychiatrist, or the condition was not according to DSM or ICD criteria.

b) Intervention

Studies that did not include CBT or CBT with Internet technology components were excluded.

c) Comparators

We did not exclude studies based on whether they had a comparator or not.

d) Outcomes

Studies that did not report acceptability, feasibility and efficacy were excluded.

e) Study design

We excluded qualitative studies, commentaries, corrections, editorial letters that did not report data and single case reports.

3.2.3. Risk of bias assessment

The risk of bias assessment was carried out by the co-authors (LBE and LW) using the Cochrane Collaboration's risk of bias tool (Higgins et al., 2011).

Disagreements were resolved by consensus or with the involvement of another member of the review group (BW or NS).

The following areas for risk of bias were assessed:

1. Sequence generation: was the allocation sequence of participants adequately randomized?

2. Allocation concealment: was the allocation sequence adequately concealed from the participants, as well as those involved in the enrolment and assignment of the participants?

3. Blinding of outcome assessment: were the patients or researchers who assessed the outcomes aware of whether the subject was in the control or experimental group?

4. Incomplete outcome data: were there incomplete data for the primary or secondary outcomes, for example due to attrition? Were incomplete data adequately accounted for?

5. Selective reporting: was the study free of suggestions that outcomes were selectively reported, for example subsets of outcomes?

3.3. Instruments used in Papers 2, 3 and 4

All the instruments are described in Table 1 (p.65)

3.3.1. The CY-BOCS: the main outcome measure

The CY-BOCS is a structured interview for mapping obsessive compulsive symptoms and is considered the gold standard for assessing OCD (Skarphedinsson et al., 2017). It was the main outcome measure used by our study.

The CY-BOCS interview evaluates the severity of obsessions and compulsions, using 10 items across five dimensions: time occupied by symptoms, interference, distress, resistance and degree of control over symptoms (Goodman et al., 1991). There has been a lack of agreement regarding CY-BOCS cut-offs. Treatment response has previously been defined as a ≥35% reduction in CY-BOCS scores. A patient is in remission when their post-treatment CY-BOCS scores is below ≤12 (Mataix-Cols et al., 2016). Recovery is considered when the patient no longer meets the criteria for the disorder and has minimal symptoms or when the patient has been in 'remission' for at least one year. Finally, relapse is described as a CY-BOCS symptom score that does not achieve a ≥35% reduction in the CY-BOCS score, when compared to the pre-treatment score, plus a Clinical Global Impressions Scale-Improvement (CGI-I) rating of 6 ('much worse') or higher for at least one month (Mataix-Cols et al., 2016).

Farhat et al. (2021) carried out a meta-analysis of 1,234 subjects from several OCD studies. This suggested that the optimal cut-off for remission was a raw score of ≤12 at post-treatment (sensitivity = 82.0, 95% CI 81.8 to 82.2, specificity = 84.6, 95% CI 84.4−84.8) (Farhat et al., 2021).

3.3.2. Secondary outcome measures

We used three secondary outcome measures (Table 1). The Child OCD Impact Scale (COIS) measures the severity of OCD symptoms (Piacentini et al., 2007). The Family Accommodation Scale (FAS) is used to assess the extent of family accommodating behaviours related to OCD rituals (Calvocoressi et al., 1999; Flessner et al., 2011). The Children's Global Assessment Scale (CGAS) is used to rate the general functioning of children and adolescents (Schorre & Vandvik, 2004; Shaffer et al., 1983).

3.3.3. Barriers to treatment measure

Barriers to treatment can include practical obstacles, a poor relationship with the therapist and perceptions that the treatment is too demanding, not helpful or of little relevance to the child's problems (Kazdin et al., 1997). Barriers to treatment were evaluated with the -modified- Barriers to Treatment Participation Scale (Kazdin et al., 1997) (Table 1).

3.3.4. Other measures used

The Strengths and Difficulties Questionnaire (SDQ), Child Behaviour Checklist (CBCL), Youth Self-Report Questionnaire (YSR), Screen for Child Anxiety Related Emotional Disorders – Revised (SCARED-R), Mood and Feelings Questionnaire (MFQ) and Children's Quality of Life Questionnaire (KINDL) were

also used for a complete evaluation of the child's well-being and comorbidities (Table 1).

3.4. Terminology: treatment acceptability, feasibility, and effectiveness

Treatment acceptability refers to the degree to which an individual perceives a treatment protocol as appropriate, fair and reasonable for a given population or problem (Tarrier et al., 2006). Treatments deemed as unacceptable are less likely to be used, regardless of their efficacy (Miller et al., 2002). Treatment acceptability was measured with the User Experience Questionnaires (UEQ), the Treatment Evaluation Questionnaire (TEQ) and Treatment Satisfaction Questionnaire (CSQ-8) (Attkisson & Zwick, 1982).

Treatment feasibility refers to whether iCBT meets a patient's needs (Myers et al., 2007) and works in practice. Feasibility was evaluated by retention rates and the therapists' Session Integrity Forms.

Treatment effectiveness refers to the capacity to improve outcomes. The effectiveness of iCBT is the effect on OCD symptoms and overall functioning. Treatment outcome was assessed with CY-BOCS and the CGI, which are the tools that are most frequently used to measure OCD symptom reduction outcomes.

Table 1. Measurement instruments used in the eCBT project

Abbre-viation	Full Name	Purpose	Age (years)	Scores and subscales	Psychometric properties	Filled in by	References
	Socio-demographic screening	Socio-demographic questionnaire	6–18			Clinician	
CBCL	The Child Behaviour Checklist	Caregiver report form that rates behavioural and emotional problems and adaptive functioning.	6–18	Internalizing/ externalizing problems and total problems score. Higher scores indicate more problems	Syndrome profiles: mean test–retest: 0.90 (Pearson's correlation), internal consistency: 0.78-0.97 (Cronbach's D), high concurrent validity	Clinician	(Achenbach, 1999; Achenbach et al., 2001)
K-SADS-PL	Schedule for Affective Disorders and Schizophrenia for School-Age Children Revised version	Used to screen for affective and psychotic disorders and other disorders	6–18	Includes a broad range of diagnoses	Inter-rater reliability: 93–100% agreement, test–retest reliability: (Cohen's N): 0.80 for anxiety disorders. Validity: high concurrent validity when compared with questionnaires on depression, anxiety, ADHD and behavioural problems	Clinician	(Jarbin et al., 2017; Kaufman et al., 1997)
CY-BOCS	The Children's Yale-Brown Obsessive Compulsive Scale	Rates the severity of OCD symptoms.	6–18	Severity of obsessions and compulsions 0–20, total score 0–40	Internal consistency (η = 0.90) and test-retest stability for the total score (ICC = 0.79). Validity: Good inter-rater agreement (ICC 0.84 for the total score)	Clinician	(Goodman et al., 1991; Storch et al., 2004)
COIS	Child OCD Impact Scale	A 33-item self-report questionnaire to assess the impact of OCD symptoms on psycho-social functioning of children and adolescents in home, social and academic environments	6–18	Parents' version: Daily Living Skills, School, Social, Family Activities Youth-report form: School, Social, Activities	Internal consistency of the parent (α =0 .94) and child reports (α = 0.91) Good convergent validity between the COIS total score and the CY-BOCS (r = 0.46)	Self-Assess-ment & Parents	(Piacentini et al., 2007)
SCARED	Screen for Anxiety Related Emotional Disorders	Parent-report questionnaire that assesses the presence of DSM-IV anxiety symptoms	8–18	3-point Likert scale (0 = 'Not True/Hardly Ever True', 1 = 'Somewhat/Sometimes True', 2 = 'Very True/Often True'). Panic/somatic, separation anxiety, generalized anxiety and school phobias	Internal consistency (α = 0.90) Good internal consistency for all the subscales of SCARED (between 0.78 and 0.87)	Self-Assess-ment & Parents	(Birmaher et al., 1997; Jastrowski Mano et al., 2012)
MFQ	The Mood and Feelings Questionnaire	The MFQ is based on DSM-III-R criteria for depression and 13 items assess the presence of depressive symptoms	6–19	'not true' = 0 points 'Sometimes true' = 1 point 'true' = 2 point Scores 0 to 26. Scoring ≤12 may indicate the presence of depression	Internal consistency (α = 0.99) Test-retest reliability (0.84, p < 0.01)	Self-Assess-ment & Parents	(Sund et al., 2001; Thabrew et al., 2018; Wood et al., 1995)
FAS	Family Accommodati on Scale	A 12-item clinician-rated instrument, designed to assess the family's accommodation to the child's OCD-symptoms during the previous month	6–17	Severity of families' accommodation, score from 0 to 48	Internal consistency (Cohen's d = 0.76 to 0.80), good inter-rater reliability (ICC = 0.72–1.0)	Only for parents	(Calvocoressi et al., 1999; Storch et al., 2007)
SDQ	Strengths and Difficulties Questionnaire	Brief behavioural screening questionnaire for child and adolescents aged 3-16 years	3-18	25 items divided in 5 scales: 5 items for each of the following areas: 1) emotional symptoms 2) conduct problems	Internal consistency (mean Cronbach α = 0.73) Cross-informant correlation (mean: 0.34)	Self-Assess-ment & Parents	(Goodman, 1999, 2001)

				3) hyperactivity /inattention 4) peer relationship problems 5) prosocial behaviour			
CGI-S	The Clinical Global Impression Severity Scale	Rating scale measures symptom severity	All ages	CGI-Severity (CGI-S) 1=normal, not at all ill; 2=borderline mentally ill; 3=mildly ill; 4=moderately ill; 5=markedly ill; 6=severely ill; 7=among the most extremely ill patients	Good internal consistency and concurrent validity	Clinician	(Busner & Targum, 2007; Leon et al., 1993)
CGI-I	The Clinical Global Impression Improvement Scale	Rating scale measures treatment response and the efficacy of treatments	All ages	CGI-Improvement (CGI-I) 1=very much improved since the initiation of treatment; 2=much improved; 3=minimally improved; 4=no change from baseline 5=minimally worse; 6= much worse; 7=very much worse	Good internal consistency and concurrent validity	Clinician	(Busner & Targum, 2007; Leon et al., 1993)
CGAS	The Children's Global Assessment Scale	Numeric scale that rates the general functioning of children and adolescents	4–18	Scoring 1–100: Lowest 1–10 (= Needs 24-hour care) to 91–100 (=Superior Functioning)	Inter-rater reliability: (ICC): 0.84, test–retest stability: (ICC): 0.69–0.95	Clinician	(Schorre & Vandvik, 2004; Shaffer et al., 1983)
CSQ-8	The Client Satisfaction Questionnaire	Portfolio of scales designed to assess consumer/ client satisfaction with health, human service, govern-mental, and public benefit programmes and services	All ages	The CSQ-8 reports a single score measuring for overall satisfaction. Total score 8 to 32, higher scores indicating more satisfaction	High internal consistency (α = 0.91)	Self-Assess-ment & Parents	(Attkisson & Zwick, 1982)
M-BTQ	Barriers to Treatment Participation Scale	To measure actual barriers experienced during treatment	All ages	4 subscales: Stressors and Obstacles that Compete with Treatment, Treatment Demands and Issues, Perceived Relevance of Treatment, Relationship with the Therapist	The M-BTQ was modified for the purposes of this project and no psychometric properties are available for the modified version	Self-Assessme nt & Parents	(Kazdin et al., 1997)
UEQ	User Evaluation Questionnaire	The UEQ allows a quick assessment of the user experience of interactive products	All ages	6 scales (attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty) and 26 items. Each item presents two opposites from one dimension (for example, not understandable (1) to understandable (7)	Satisfactory level of reliability and construct validity	Self-Assess-ment & Parents	(Schrepp et al., 2017). (Laugwitz et al., 2008)
	Session Integrity Form	Assesses the integrity of treatment components within each session	4–18			Clinician	

3.5. Participants

The eCBT study was conducted by the Child and Adolescent Mental Health Services (CAMHS) of St. Olav's University Hospital, Trondheim, Norway and the

CAMHS department of the Hospital of Aalesund, Norway. The inclusion and exclusion criteria are described in Table 2.

Table 2. Inclusion and exclusion criteria

Inclusion criteria
No other psychiatric disorders (according to DSM-5) with higher treatment priority (i.e., primary anorexia nervosa, psychosis, and severe depression).
CY-BOCS entry score of 16 or above
7 to 17 years of age
Patients with OCD

Exclusion criteria
Presence of other psychiatric disorders (according to DSM-5) with higher treatment priority (i.e., primary anorexia nervosa, psychosis, and severe depression).
Intellectual disability
Ongoing psychological treatment for OCD
Lack of language proficiency

If patients met the study's eligibility criteria, they and their parents were informed about the eCBT study and had the opportunity to ask questions. Informed consent was obtained from the children, depending on their age, and informed consent from the parents. The families who wished to participate were enrolled into the study.

A total of 82 children and adolescents with suspected OCD were referred to CAMHS, St. Olav's University Hospital, Trondheim, between January 2018 and November 2019 and evaluated for participation in the study. We found that 47 patients did not fulfil the inclusion criteria for the study. The other 37 patients were eligible, and they and their parents were informed about the eCBT study. Of these, 26 families agreed to participate in eCBT and 11 preferred intensive face-to-face CBT group treatment. The first patient in the eCBT group did not receive the webcam sessions, due to initial technical problems, and was excluded from the analyses (Figure 2).

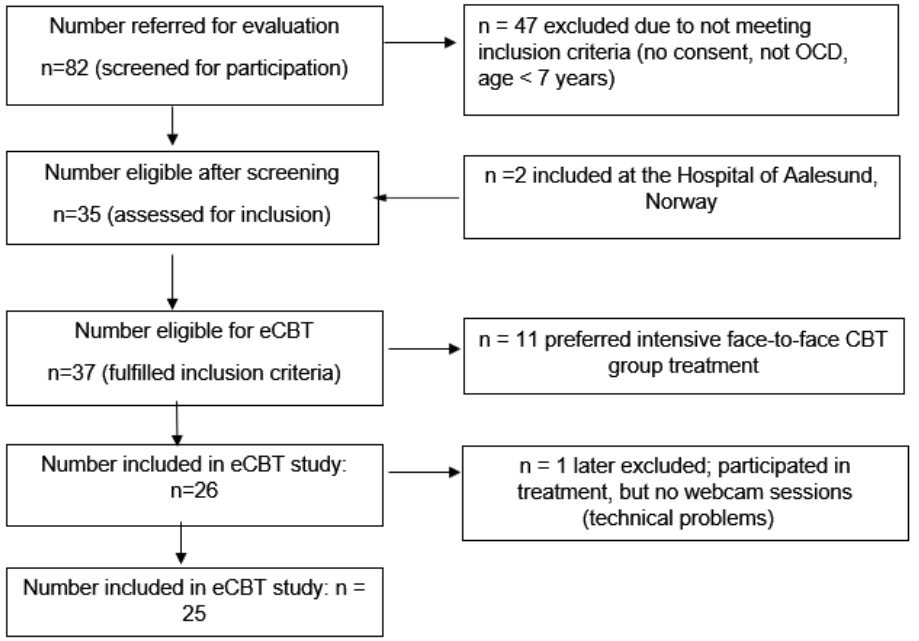


Figure 2. eCBT participants flow chart

3.6. eCBT Intervention

Paper 2 (Wolters et al., 2020) provides a detailed overview of the eCBT intervention.

3.6.1. Statistics for the eCBT study (Papers 3 and 4)

In Paper 3 we describe 25 patients aged 8 to 17 years with OCD. Treatment feasibility was assessed by checking the number of treatment dropouts and examining the Session Integrity Forms. Treatment acceptability was assessed with four questionnaires. The CSQ-8 enabled us to calculate group mean scores and standard deviations for each item. These were separately calculated for children and parents. The UEQ provided group means and standard deviations for all six subscales for the children parents. The TEQ was analysed to rate each item for each child and parent. The -modified- Barriers to Treatment Participation Scale (BTPS) descriptively summarizes the frequency of perceived barriers to treatment. Treatment outcomes for OCD severity were examined by calculating the percentage improvement in the CY-BOCS scores from baseline to post-treatment. The criterion for treatment response was defined as a ≥30% reduction in symptoms and the criterion for clinical remission was a CY-BOCS score of ≤10 (Franklin et al., 2011; Piacentini et al., 2011; Storch, Lewin, et al., 2010; Torp et al., 2015). Longitudinal outcomes on the CY-BOCS were assessed at baseline, post-treatment and followed up three and six months later. They are presented as group mean scores and standard deviations at the respective assessment points. SPSS software, version 25 was used (IBM Corp., 2017).

Paper 4 benchmarked the outcomes for the eCBT sample by using the historic NordLOTS sample, which was based on traditional face-to-face CBT. Participants were compared by the baseline CY-BOCS total score, sex, age, age of onset and comorbidities.

We used linear mixed models (LME) to evaluate outcome changes in the CY-BOCS total score (Gueorguieva & Krystal, 2004; Herring, 2013). A linear mixed model uses all the data that is available to estimate model parameters and it also includes missing data on participants at some time points. Linear mixed models are generally recommended for longitudinal studies, because they have the ability to handle missing correlated and repeatedly measured observations (Yoo, 2010). Maximum likelihood estimation was used and included fixed effects for time (week 14 versus baseline) and treatment cohort (NordLOTS versus eCBT) and their interactions. The model included random effects for intercept.

We explored non-inferiority to benchmark our data against the NordLOTS outcomes and followed the current guidelines (Piaggio et al., 2012). An important part of this process was to examine the inferiority margin (Piaggio et al., 2012). We determined whether the eCBT was inferior to the NordLOTS outcomes by using confidence intervals. We were able to establish non-inferiority if the lower limit of the two-sided 95% CI of the difference of the mean was less than the pre-specified non-inferiority margin (Piaggio et al., 2012; Yoo, 2010).

We set non-inferiority at four points on the CY-BOCS scale using 95% CIs. This indicated that eCBT would be non-inferior to the NordLOTS CBT if the upper limit

of the 95% for the difference between the eCBT and the NordLOTS CBT was less than four. This meant that we would be 95% confident that the real value of the difference between these cohorts at week 14 would not be worse than four points on the CY-BOCS total score.

Power-calculations indicated that four points on the CY-BOCS total score would show that 21 participants in the eCBT group would be sufficient to show noninferiority, with alpha of 0.05 and a power of 0.80.

Multivariate chi-square tests were conducted on binary outcomes, such as remission. Participants with data and missing data were compared. Missing data were replaced by using a sequential regression multivariate imputation algorithm (Rubin, 2004). This imputation model included all the baseline demographics and outcome measures and 20 imputed data sets were generated, according to the guidelines (Carpenter & Kenward, 2012; Graham et al., 2007) to ensure that the estimates, CIs and p-values were reliable. The SAS 9.4 proc MIANALYZE procedure was used to generate the imputed datasets. The results of the 20 complete case analyses were combined with Rubin's rules (Rubin, 2004). The results were reported as F statistics. Tests were two-tailed and a p-value of less than 0.05 indicated statistical significance. The computation of a combined F statistic was conducted with the SAS macro COMBCHI (Allison, 2000).

SAS Statistical Software, version 9.4, was used to conduct the linear mixed models, using the proc mixed procedure and multiple imputation. All other analyses were performed with SPSS version 26.0.

3.6.2. Ethics

The study was approved by the Regional Committee for Medical and Health Research Ethics (No2016/716/REK Nord) and registered with the ISRCTN (https://www.isrctn.com/) registry (trial ID ISRCTN37530113). The study procedures were in accordance with the principles of the Declaration of Helsinki (World Medical Association, 2013) and good clinical practice (GCP) (World Health Organization, 2005).

3.7. Summary of results

3.7.1. Paper 1: systematic review

The systematic review initially identified 3,537 references, 1,214 duplicates were removed, resulting in 2,323 references. 2,276 references were excluded. After screening titles and abstracts, we finally screened thoroughly 47 references. Forty references did not fulfil selection criteria. Seven papers describing six original studies were deemed eligible for inclusion in the systematic review. The eligible papers were three randomized controlled trials (Comer et al., 2017), (Lenhard. et al., 2017) and (Storch et al., 2011), one open trial (Lenhard et al., 2014), one single case non-concurrent multiple baseline design (Farrell et al., 2016), and one case series (Comer et al., 2014).

The six eligible papers included 96 participants: 47 girls, 49 boys. Four of the six papers focused on participants from 7 to 17 years of age and two (Comer et al. (2014) and (2017) comprised children from 4 to 8 years of age.

Therapist involvement varied from minimal, with occasional indirect contact via messages or phone calls (Lenhard et al., 2014; Lenhard. et al., 2017), to substantial contact via frequent video-teleconferencing (Storch et al., 2011). Parents were actively involved in the treatment process in all six studies.

We examined the feasibility of the treatment by documenting subjects who dropped out. The drop-out rate ranged from zero in Comer et al. (2014) and Farrell et al. (2016) to two patients in Storch et al. (2011). Only four patients (4.2%) dropped out of the treatment programmes across the six studies.

Acceptability was rated as good or very good in the study by Lenhard et al. (2014). The Lenhard. et al. (2017) RCT only assessed the adolescents' views. This showed that: 46% of the adolescents were satisfied, 50% were satisfied most of the time, but would have liked to meet a clinician occasionally, and 4% would have preferred face-to-face treatment. All the mothers in Comer et al. (2014) and Comer et al. (2017) reported good alliance with the therapist and high satisfaction with the treatment. Storch et al. (2011) reported very high satisfaction with the treatment, but it was only rated by the parents. Farrell et al. (2016) did not report on acceptability. All the studies used the CY-BOCS to assess the severity of OCD symptoms. Storch et al. (2011) reported a 56.1% reduction in OCD symptoms following iCBT. Lenhard et al. (2014) and Lenhard. et al. (2017) reported an average reduction of 41% in the CY-BOCS scores in their open trial and 26% in their RCT. Farrell et al. (2016) reported that symptoms had reduced by 49% post-treatment. Comer et al., reported a 35% average reduction in CY-BOCS scores post-treatment in their RCT (Comer et al., 2017) and 28% in their case series (Comer et al., 2014).

Lenhard et al. (2014) reported significant improvements at the three-month follow up, which was maintained at the six-month follow up. In the later RCT, the participants continued to show significant improvements between post-treatment and the three-month follow up (Lenhard. et al., 2017). Comer et al. (2017) reported significant improvements from pre-treatment to the six-month follow up. Farrell et al. (2016) reported 'reliable changes' for 8 out of 10 children whose CY-BOCS' scores improved by at least 8.33 points from post-treatment to the six-month follow up. The results showed some risk of bias (Higgins et al., 2011), mostly due to the lack of randomization (Comer et al., 2017; Lenhard. et al., 2017; Storch et al., 2011) and blinding of outcomes (Comer et al., 2014; Comer et al., 2017; Farrell et al., 2016; Lenhard et al., 2014; Lenhard. et al., 2017; Storch et al., 2011).

3.7.2. Paper 2: eCBT treatment package and study protocol

The eCBT intervention is an innovative treatment package for children and adolescents with OCD. Five components have been integrated into the eCBT treatment process: videoconferencing sessions, face-to-face sessions, an app that aims to support the treatment structure, psychoeducation videos and frequent online ratings that allow direct feedback from the patient. The eCBT package combines face-to-face treatment sessions with videoconferencing sessions from home. The face-to-face sessions have been designed to build a therapeutic alliance and may provide the therapist with more information, because observations are not limited to the scope of the webcam. During the videoconferencing sessions, the therapists help the children to carry out ERP

exercises at home or in other places that trigger OCD symptoms. The videoconferencing sessions aim to improve the ecological validity of the treatment. They also encourage generalization of CBT principles, by extending the treatment from the therapist's office into settings where the problems naturally occur. In addition, receiving treatment at home may be more convenient and may reduce travelling time, costs, and stigma. Children and therapists have access to the video-teleconferencing software via their smartphones or computers. The app system consists of a smartphone app for the children and parents, which is connected to an Internet -based application on the therapist's computer. The main goals of the app system are to increase motivation and treatment adherence and to encourage the parents to get involved in the treatment process. This app system also enables therapists to personalize the treatment to the child's individual needs. The app provides information about OCD and CBT, through psychoeducation videos, provides support and structured ERP exercises at home and enables the therapist to closely monitor the treatment progress. The Internet-based application used by the therapists enables them to coordinate and monitor the treatment. The app can be used during the treatment sessions with the therapist and independently at home.

3.7.3. Paper 3: acceptability and feasibility of eCBT

None of the 25 patients dropped out during the treatment. Table 3 shows the clinical characteristics of the 25 participants and outcomes post-treatment and during follow up.

Table 3. Clinical characteristics and assessments

Age (years)	Gender	Comorbidities (K-SADS)	Medication (dose/day)	Number of sessions: face-to-face/webcam	CY-BOCS total score				CGI–Severity / CGI-Improvement			
					Pre	*Post*	*3 m*	*6 m*	*Pre*	*Post*	*3 m*	*6 m*
12	M	SAD, GAD, ADHD, Tic disorder, ASD	Guanfacine (4 mg)	14/1	34	17	0	0	6	3/2	1/1	1/1
17	F	None	None	9/6	25	6	0	0	5	1/1	1/1	1/1
9	M	Depression, Eating disorder	None	7/1	18	11	11	21	4	1/2	1/3	5/3
16	F	None	None	10/11	18	14	18	N.A	4	4/3	5/3	N.A
10	F	SAD, Spec. phobia, ADHD, Tic disorder	None	6/1	25	0	0	0	5	1/1	1/1	1/1
10	F	GAD	None	6/3	24	0	0	0	4	1/1	1/1	1/1
17	M	Tic disorder	None	10/2	35	22	20	18	6	4/3	2/4	1/4
15	F	None	None	10/2	24	2	2	2	5	1/1	1/1	1/1
13	M	Tic disorder	None	10/6	31	8	0	0	5	4/1	1/1	1/1
12	F	Eating disorder	Risperidone (1 mg)	14/1	34	33	N.A	5	6	6/3	N.A	1/1
13	F	GAD	None	10/7	31	23	N.A	N.A	6	5/3	N.A	N.A
13	F	None	Methylphenidate (40 mg)	9/4	20	5	2	1	4	1/1	1/1	1/6
14	F	None	None	12/9	27	7	4	19	5	1/1	2/1	4/3
17	M	ASD	None	3/2	21	0	N.A	N.A	5	1/1	N.A	N.A
8	F	None	None	7/5	25	0	0	0	4	1/1	1/1	1/1
13	M	None	None	10/6	30	0	0	0	4	1/1	1/1	1/1
16	M	N.A	None	7/7	25	20	N.A	N.A	5	4/3	N.A	N.A
13	F	ASD	None	10/3	29	12	1	0	6	3/1	1/2	1/1
13	F	None	None	9/4	18	12	12	12	4	3/3	3/3	2/3
8	M	None	None	8/3	31	0	0	0	5	1/1	1/1	1/1
14	M	Bipolar disorder	Aripiprazole (20 mg)	4/6	21	17	N.A	N.A	4	3/3	N.A	N.A
17	F	None	None	8/9	32	0	0	0	5	1/1	1/1	1/1
8	M	PTSD	None	7/5	20	10	2	0	4	1/2	1/1	1/1
16	F	Spec. phobia, ADHD	Methylphenidate (20 mg)	11/4	21	14	6	3	5	2/1	2/1	1/1
14	M	ASD, Tic disorder	None	9/4	25	0	0	0	3	1/1	1/1	1/1

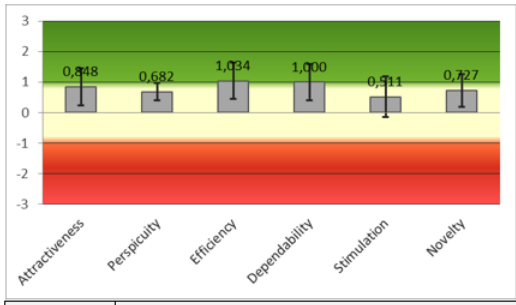
K-SADS Kiddie Schedule for Affective Disorders and Schizophrenia, *CGI* Clinical Global Impression scale, *CY-BOCS* Children's Yale-Brown Obsessive–Compulsive Scale, *GAD* Generalized Anxiety Disorder, *SAD* Separation Anxiety Disorder, *ADHD* Attention Deficit Hyperactivity Disorder, *ASD* Autism Spectrum Disorder, *PTSD* Post Traumatic Disorder, *N.A.* Not available, *M* male, *F* female

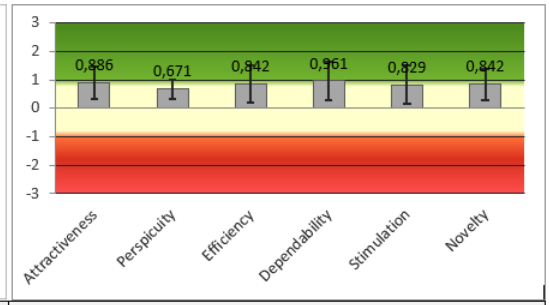
Children and parents were satisfied with the eCBT. The CSQ-8 results showed mean scores of 27.58 (SD 0.67) for the children and 29.5 (SD 3.74) for the parents (range 8 - 32) (Table 4).

Table 4. Client Satisfaction Questionnaire (CSQ-8): children's and parents' ratings

Item	Children (n=22) mean (SD)	Parents (n=18) mean (SD)
1. Quality of service	3.41 (0.59)	3.67 (0.49)
2. Kind of service wanted	3.50 (0.60)	3.61 (0.50)
3. Needs met	3.30 (0.76)	3.56 (0.51)
4. Would recommend to friend	3.65 (0.57)	3.78 (0.43)
5. Satisfaction with help received	3.32 (0.84)	3.67 (0.49)
6. Dealt with problems	3.52 (0.60)	3.72 (0.46)
7. Overall satisfaction	3.48 (0.67)	3.83 (0.38)
8. Would return to programme	3.40 (0.67)	3.67 (0.49)
Total score (range 8–32)	27.58 (0.67)	29.5 (3.74)

User experiences were rated as 'average' by both the children and parents in all the UEQ subscales (Figure 3).





Subscale	Children (n=22, missing 3); mean (SD)	Parents (n=19, missing 6); mean (SD)
Attractiveness	0.85 (1.46)	0.88 (1.24)
Perspicuity	0.68 (0.66)	0.67 (0.76)
Efficiency	1.03 (1.43)	0.84 (1.46)
Dependability	1.00 (1.43)	0.96 (1.51)
Stimulation	0.51 (1.57)	0.83 (1.47)
Novelty	0.73 (1.28)	0.84 (1.22)

Figure 3. User Experience Questionnaire (UEQ): children's and parents' ratings

Most children and parents evaluated the eCBT package components positively, rating the face-to-face and videoconferencing sessions positively in the TEQ (Figure 4).

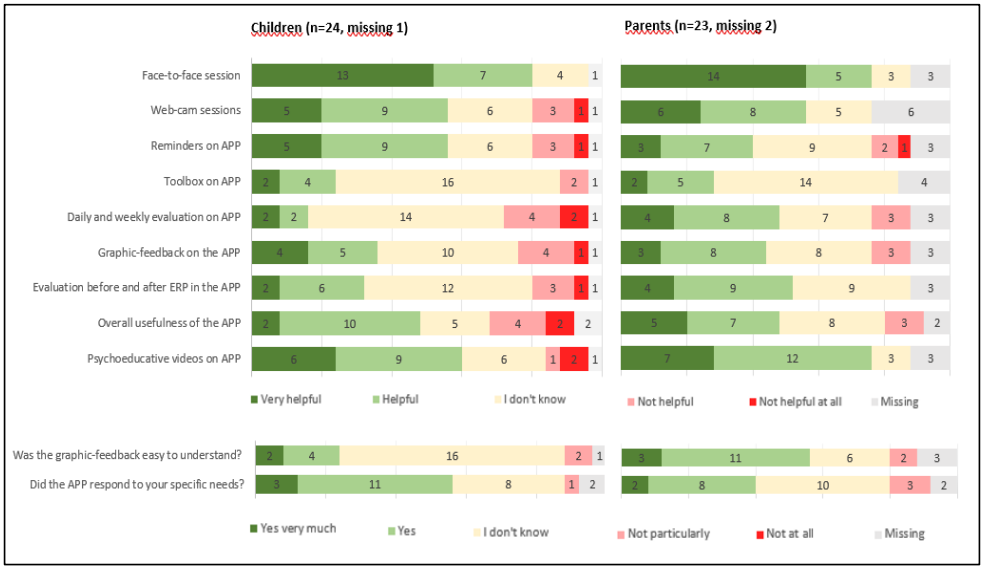


Figure 4. Treatment evaluation questionnaire

Barriers to treatment were generally rated as low. In the -modified- BTPS, the most frequent rated barrier to treatment for children was “My problems have not improved, and I need longer treatment”, endorsed as sometimes a problem by five and often a problem by four children (Figure 5). The most frequent rated barrier to treatment for parents was work-related issues, which affected four parents (Figure 6).

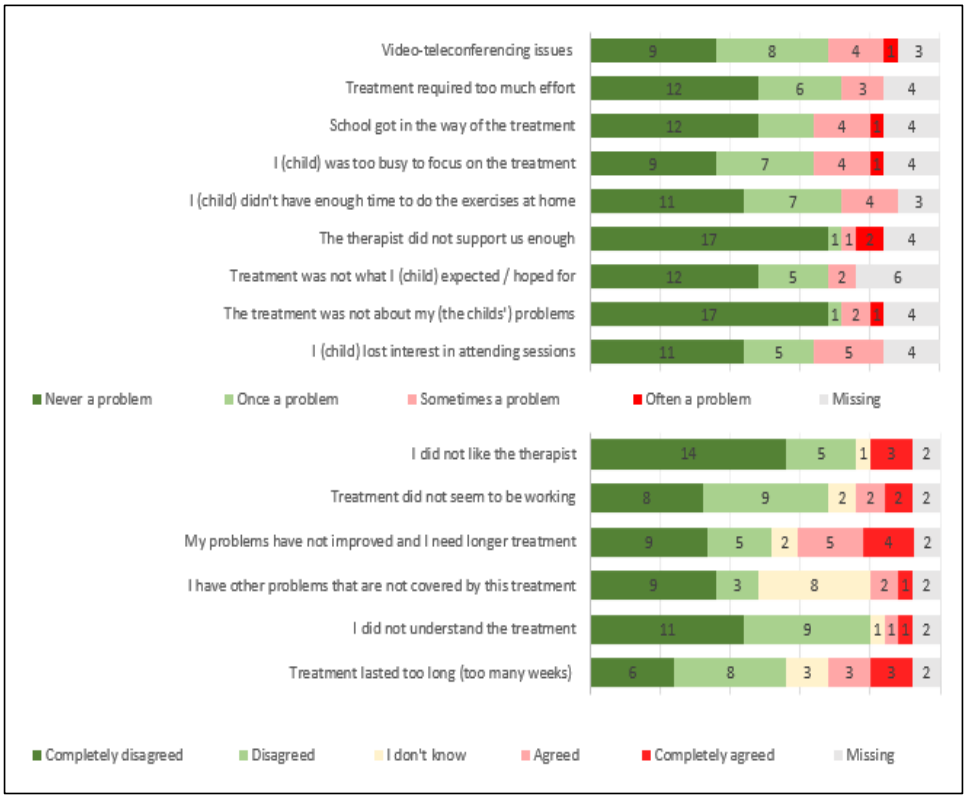


Figure 5. Modified barriers to Treatment Participation Scale: children.

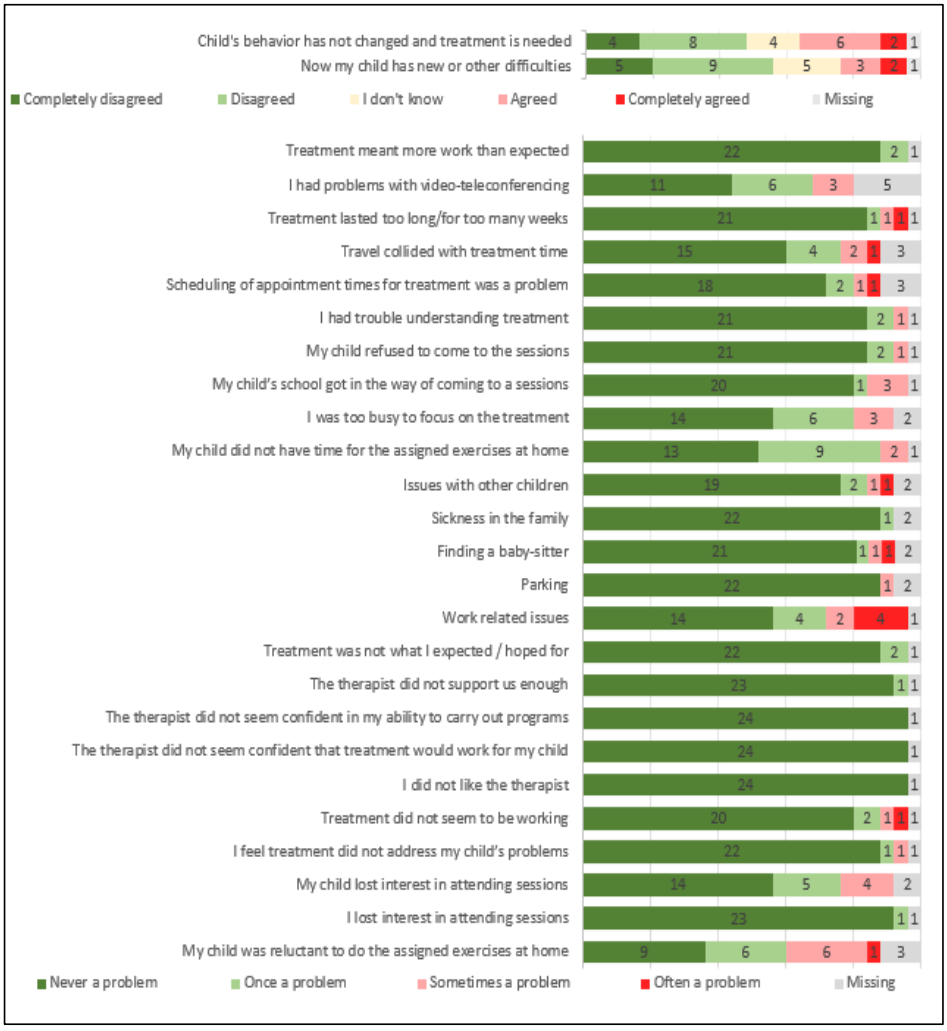


Figure 6. Modified barriers to Treatment Participation Scale: parents.

3.7.4. Paper 4: eCBT vs standard CBT (NordLOTS)

In the fourth paper, we benchmarked the eCBT outcomes of the 25 paediatric patients with OCD against the traditional face-to-face CBT offered to 269 subjects by NordLOTS, which is the largest paediatric OCD CBT study to date (Torp et al., 2015). The results showed an estimated difference of -2.5 (95% CI -0.3 to 5.3) in favour of eCBT, below the four-point difference margin (Figure 7).

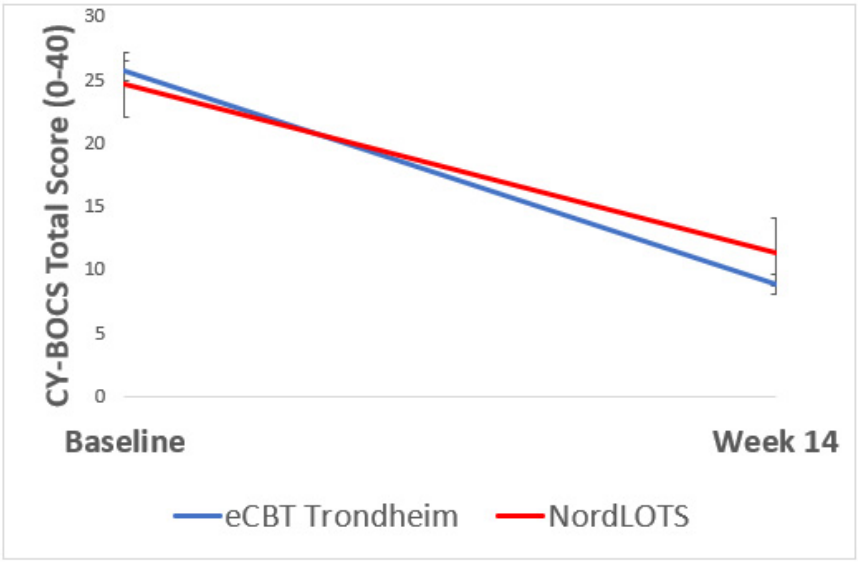


Figure 7. Adjusted intent-to-treat CY-BOCS total score across treatment cohorts.

The difference between the mean reduction in the CY-BOCS total scores (mean= 3.6) was significant: (t)264) = 2.04, p = 0.04 (Table 5). This indicated significantly greater symptom reduction in the eCBT sample than with NordLOTS.

Table 5. Post-treatment group-specific outcomes and response rates

	Estimated mean or rate (95% CI)[a]		
Primary outcomes	**eCBT**	**NordLOTS**	**Effect sizes (95% CI)[b c]**
CY-BOCS total score	8.9 (6.2 to 11.6)	11.4 (10.6 to 12.2)	0.35 (-0.06 to 0.76)
Reduction from baseline CY-BOCS total score	-16.9 (-20.2 to,13.5)	-13.2 (-12.2 to -14.3)	0.41 (0.00 to 0.82)
Symptoms in clinical range (CYBOCS ≥ 16)	24.0% (9.4% to 45.1%)	29.1% (23.3 to 34.8%)	0.11 (-0.2 to 0.52)
Remission (CY-BOCS ≤ 12)	68.0% (46.1% to 89.9%)	57.6% (51.4% to 63.8%)	0.21 (0.20 to 0.62)
Response rate	68.0% (46.5% to 85.1%)	59.6% (53.5% to 65.8%)	0.17 (-0.24 to 0.58)
Attrition rate	1 (4.0%)	26 (10.7%)	

[a] For CY-BOCS total score, estimated mean score at post-treatment from the fitted **LMM.** For the categorical outcomes, the estimated rate at post-treatment.
[b] For CY-BOCS total score, the between-groups difference in estimated mean score at posttreatment. For the categorical outcomes, between-groups difference in rate at post-treatment
[c] Positive effect size suggests that eCBT was more effective.

The group-specific outcomes post-treatment and the response rates are shown in Table 5. The estimated change in mean CY-BOCS total scores from baseline to post-treatment was significantly greater in the eCBT group than in NordLOTS and the change in the mean difference was 3.6 ($t(264)=2.04$, $p=0.04$). The eCBT patients achieved more OCD symptom reductions than the NordLOTS cohort. We found that 59.6% of the NordLOTS participants and 68.0% of the eCBT cohort responded to treatment. The estimated percentage of patients who still had symptoms in the clinical range post-treatment was 24% (95% CI 9.4% to 45.1%) for eCBT and 29.1% (95% CI 23.3% to 34.8%) for NordLOTS.

Attrition and remission rates differences were also examined. Attrition rates were similar, with no significant differences between eCBT and NordLOTS (chi-square

(1, 293)=0.880, p=0.348). Remission rates were 68.0% for the eCBT group and 57.6% for the NordLOTS group. The multivariate chi-square test showed no statistically significant differences between the groups (p=0.317).

Table 6. Parameter estimates from fitting elevation and slope to the CY-BOCS.

Parameter	Final model
Composite model, estimate (**SE)**	
Intercept	25.760 (1.304)***
Weeks	-1.205 (0.121)***
Group	-1.136 (1.363)
Week*group	0.259 (0.127)*
Variance components	
Level-1 – within person	34.317 (2.929)***
Level-2 – in initial status	8.174 (2.597)***

* p<0.05, ***p<0.001,

Pairwise comparisons post-treatment showed that the difference between the eCBT and NordLOTS treatment outcomes were not statistically significant (t(264) = 1.76, p = 0.08). The mean estimate difference was 2.5, in favour of eCBT, with a 95% CI from -0.3 to 5.3 (Table 6).

Chapter 4: Discussion

During the last 10 years we have seen an increase in both the development of, and research into, electronic health technology for mental health (Ameringen et al., 2017; Bunge et al., 2016; Firth et al., 2016; Rogers et al., 2017; Sucala et al., 2017). The use of Internet and mobile devices have increased all over the world (The World Bank, 2016) and they are extensively used during childhood and adolescence (Ólafsson K., 2013). “There has also been an increasing interest in promoting health through the use of electronic and mobile health technology” (WHO, 2013). Despite this, we found a limited number of studies that focused on iCBT interventions for paediatric OCD. This was a surprising result, given the much higher numbers of iCBT studies for other mental disorders in children and adolescents, for example depression, and the studies of iCBT interventions for adults with OCD. One explanation could be the lower prevalence of paediatric OCD compared to other mental disorders. In addition, legal reasons may have led to the development of adult iCBT programmes before those for paediatric patients. Paediatric studies require assent or consent from both children and parents and higher safety concerns for children may be another issue.

The effectiveness of iCBT for reducing OCD symptoms in children varied considerably between the studies we looked at, from 26% (Lenhard. et al., 2017) to 56% (Storch et al., 2011). These results varied depending on the nature of the intervention. We found that both the development and the application of iCBT programmes were driven by different strategies, and this had a clear impact on their effectiveness. Some studies aimed to overcome geographic barriers by

delivering CBT via videoconferencing (Storch et al., 2011), while others sought to improve treatment responses by providing more intensive interventions, including iCBT (Comer et al., 2014; Comer et al., 2017; Farrell et al., 2016). Other programmes put the emphasis on low-cost and easily accessible Internet-based self-help programmes with very limited therapist involvement (Lenhard et al., 2014; Lenhard. et al., 2017). Our systematic review included studies published up to 2017 and identified six papers covering 96 subjects. However, the field is not static. New interventions are being developed and tested, which is broadening the evidence base of iCBT (Aspvall, 2020; Conzelmann et al., 2022; Hollmann et al., 2021; Lenhard et al., 2020; Lenhard et al., 2021; Wickberg et al., 2022).

4.1. Acceptability of eCBT

iCBT for paediatric OCD seems to be well-accepted by children and their parents. Five of the six eligible studies in our systematic review reported high treatment acceptability (Babiano-Espinosa et al., 2019). The sixth did not report on acceptability (Farrell et al., 2016). The participants who took part in our eCBT programme reported overall satisfaction with the eCBT package. In fact, when we used the CSQ-8, which tracks general satisfaction with an intervention, it yielded very high mean total scores. Participants were ‘mostly satisfied’ or ‘highly satisfied’ with their eCBT treatment. This was the case for the children as well as their parents (Babiano-Espinosa, Wolters, et al., 2021).

Although the manualized treatment package was new and innovative, it was provided by experienced clinicians who were familiar with OCD treatment, and this might have had an impact on the high acceptability of eCBT. It has been

argued that the therapeutic relationship that exists during CBT plays an essential role in positive therapy outcomes (Easterbrook & Meehan, 2017).

As expected, there were some variations when it came to the acceptability of different eCBT package elements. Most children and parents were positive about the face-to-face and videoconferencing sessions. This was not surprising, because the videoconferencing sessions provided convenient treatment at home. It also provided the opportunity to practice therapist-guided ERP easily and realistically in the child's natural environment, where most of the obsessions are generated and most of the compulsive behaviours are performed. However, face-to-face sessions were rated higher than the videoconferencing sessions. Both the patients and the therapists reported some technical issues during the initial phase of the programme, such as poor Internet connections, but these were addressed relatively easily. Our observations, independent of the ratings, was that some children were easier to motivate and worked better during face-to-face sessions. Others found that using a webcam at home, where they were exposed to natural situations, was more effective.

These findings may reflect the importance of individual preferences. One study explored an Internet-based CBT program with low therapist intensity, where clinicians spent an average of 17.5 minutes a week with patients (Lenhard, Andersson, et al., 2017). The authors reported that 46% of adolescents stated that they were satisfied with the online treatment. In addition, 50% were satisfied with the Internet-based format most of the time but would have liked to meet with a clinician occasionally. Only 4% would have preferred face-to-face treatment.

Therefore, the opportunity to combine webcam and face-to-face treatment gives clinicians the opportunity to offer personalized treatment that is adapted to individual needs and preferences.

We also received specific feedback about the acceptance of the eCBT app. Overall, this was rated from neutral to moderately positive by the children and their parents. This broad-spectrum ranking contrasted with the more consistent ranking of high overall satisfaction with the eCBT package in the CSQ-8. One possible explanation is that the app was primarily associated with the hard exposure element of the programme. In addition, it is not surprising that the children gave the app lower scores when it came to the novelty and attractiveness subscales. The children may have compared the eCBT app to games, social media, and other interactive apps, which were created for entertainment purposes and tend to be more fun and more attractive than treatment tools. The parents' evaluations of the app were more positive than the children's evaluations. A possible explanation for this might be the different roles of children and parents during treatment. In addition, the eCBT app served different purposes for children and their parents. Children may have been less positive about the app because they associated it with homework exercises and demanding exposure work. Meanwhile, the parents may have seen the role that the app was playing in gradually reducing the need for family accommodation of the child's OCD and their role as their child's supporters. This may have led to more positive evaluations from the parents.

When it came to specific app features, children and parents were most positive about the psychoeducation videos. We found that 19/23 (83%) of the parents and 15/24 (60%) of the children who responded to that question rated the videos as

helpful or very helpful. Two children, but none of the parents, said that the videos were not helpful. Six children were neutral about the videos. We believe that most of the participants were positive about the videos because they offered useful information about OCD in the form of short video clips that were easy to understand. A possible explanation for the six children who were neutral about the videos could be that they compared the videos about OCD with the impressive audio-visual contents of games and other entertainment programmes.

While most parents were positive about the questions on the eCBT app that monitored treatment progress, the aim of these questions seemed to be less clear for the children. The assessment questions were voluntary and were daily and weekly. Examples to the questions were ‘How much has OCD disrupted your day?’ (Hvor mye har OCD ødelagt for deg I dag?) and ‘How was your mood today?’ (Hvordan var humøret ditt I dag?). Perhaps answering the extra assessment questions was too much work for some children on top of the exposure exercises. Therefore, although the evaluation of the app was largely positive, some features need improvement. Participants mainly seemed to use the app functions which involved both the therapist and patient. Functions like the toolbox, which children could explore on their own, were not used and may need to be better explained and integrated into the sessions. The acceptability of the toolbox was mainly neutral with 16/24 children and 14/23 parents responding don’t know. Functions like the toolbox and the assessment questions could be improved, so that more patients use them. For example, we could use pop-ups and a more attractive visual interface. The most frequently used and vital functions of the app were the OCD symptom inventory and the list of ERP exercises, including monitoring how well the children carried out the exercises.

Because the patients and therapists shared the same information, the app facilitated continuous communication between them and contributed to improving both the structure of the sessions and communication. The usefulness of the exercise reminders was ambiguous. Highly motivated children did not need reminders, while those with little motivation could see them as annoying. The reminders were programmed by the therapists, and it is possible that these could be improved by allowing patients to personalize them to an extent. We found that 14/24 children did like the reminders and 9/23 parents were neutral about them. This makes sense, as the reminders were directed at the children, to help them to remember their exercises, not to the parents. The reminders should be also individualized to reflect the needs and preferences of the patient, ranging from very low intensity reminders to very clear reminders. Most users did not use all the possible functions of the eCBT app, which is the case with most apps. A good strategy for future apps may be to concentrate on the core functions that are used daily, such as exercises lists, symptom lists and videos. Other more sophisticated features, such as the toolbox, reminders, and daily/weekly questions, could then be applied when needed. On the other hand, keeping the eCBT app simple and straightforward may be the best strategy for delivering effective eCBT for paediatric OCD. Ensuring that the app is user friendly, personalized and integrated with other treatment elements are the key elements for success.

4.2. Feasibility of eCBT

All the studies in our systematic review reported high feasibility. This was in line with the high acceptability and feasibility of iCBT for paediatric depression and anxiety disorders (Reyes-Portillo et al., 2014; Rooksby et al., 2015).

The primary feasibility measure for our eCBT intervention for children and adolescents with OCD was how many patients dropped out and did not complete their treatment. The fact that none of the 25 participants dropped out, suggests that eCBT was a feasible treatment for most participants.

Both the parents and children reported very few barriers to treatment, and these tended to focus on single issues, which suggested that there were no overall systematic barriers. The most common barrier was ‘work-related issues’, which were ‘often a problem’ for 4/25 parents (16%). This probably reflected demanding situations for whole families, where parents’ jobs interfered with the need to support their child. The item that was most frequently endorsed by the children was ‘My problems have not improved, and I need longer treatment‘. Four completely agreed with this statement and five agreed. The patients’ reluctance to do the homework they were assigned was a common rated barrier to treatment. However, this is a well-known problem with exposure therapy that is common for all modes of delivery (McKay, 2017). Even if the app aims to motivate the patient and structure the exposure process, it still implies hard work. However, most of the participants overcame this reluctance, as they succeeded with ERP.

In addition, the eCBT app was only developed for Android phones, due to limited financial resources, and the project provided suitable android phones for non-Android users. Obviously, it would have been more convenient if all patients could have used their own phone, rather than having to use a second phone. For example, sometimes the children could not use the Android study phone for eCBT, because they forgot to charge them or thought their parents had done that.

Overall, our results suggest that eCBT provided a feasible treatment for most participants. There were barriers to treatment in some cases. The parents' work-related issues may be overcome by offering more support to them when their child is receiving treatment. The children's reluctance to do the exercises can be mitigated by psychoeducation, but some avoidance is 'human' and inherent to ERP.

4.3. Effectiveness of eCBT

The eCBT intervention showed a 64% mean reduction in symptoms, as measured by the CY-BOCS change from baseline to post-treatment. The CY-BOCS scores had decreased further at the three-month and six-month follow-ups. To substantiate these findings, we explored the effectiveness of eCBT further. We did this by comparing eCBT outcomes with historical outcome data from NordLOTS, the largest study to date on the effectiveness of CBT for paediatric OCD. The eCBT and NordLOTS samples were mainly comparable and there were no differences in the OCD severity scores at baseline, male to female ratios, family settings and the rates of comorbidities. One difference was that the NordLOTS did not include patients with both OCD and ASD, but our eCBT study

did. However, Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS) was allowed by the NordLOTS study if the OCD symptoms caused greater impairment. This means that there was one patient with OCD and ASD in the NordLOTS sample (Torp et al., 2015). We found that 4/25 (16%) patients included in the eCBT study had a diagnosis of ASD. In addition, the overall age of the patients, and their age at the onset of OCD, were slightly lower in the eCBT group than in the NordLOTS sample.

When we compared the results of the two studies this showed that the eCBT outcomes were not inferior to the NordLOTS study. The mean estimated difference in the CY-BOCS total scores was -2.5 (95% CI -0.3 to 5.3) in favour of eCBT, which was within the four-point difference margin. This could indicate that eCBT was more effective in reducing OCD symptoms than traditional face-to-face CBT. However, this needs to be explored further by randomized control trials with head-to-head comparisons. We found no significant differences between the response and remission rates in the two studies. However, the interaction of group time was significant. It showed that the eCBT group saw a greater reduction in the severity of their OCD symptoms during treatment than the NordLOTS group.

Taken together, these results suggest that eCBT can be at least as effective as traditional face-to-face CBT.

4.4. eCBT for OCD versus other iCBT interventions for OCD

The results for eCBT for OCD seemed to be in line with results of other studies using Internet technology to deliver CBT for paediatric OCD. More specifically, Storch et al. (2011) reported a 56.1% reduction in the CY-BOCS total score and Farrell et al. (2016) reported a 49% reduction in the same score. Lenhard et al., reported an average reduction of 41% (Lenhard et al., 2014) and 26% (Lenhard, Andersson, et al., 2017) in the CY-BOCS scores in their open trial and RCT, respectively. Comer et al., reported a 35% and 28% average reduction in CY-BOCS scores post-treatment in their RCT (Comer et al., 2017) and case series (Comer et al., 2014), respectively. Meanwhile, our eCBT programme demonstrated a 63.8% reduction in symptoms from baseline to post-treatment.

4.4.1. eCBT for OCD and comorbidities

The patients who showed the least improvements often had comorbidities, such as a tic disorder, general anxiety disorder, bipolar disorder or eating disorder. In addition, one non-responder in our sample was later diagnosed with comorbid disorders, namely an eating disorder, emetophobia and general anxiety disorder. These comorbidities were probably not diagnosed during their initial assessment, which was carried out with Kiddie-SADS, because they were overshadowed by the OCD symptoms. Another patient had difficulties in following up treatment and homework exercises probably due to difficulties with executive functioning. ADHD evaluation was recommended, but not accepted.

Another patient who showed a small improvement had very poor insight and a tendency to deny and hide the OCD symptoms. However, they did not have a comorbid diagnosis. As mentioned above, 4/25 (16%) of the eCBT sample had ASD. Treating children and adolescents with OCD and ASD has been associated with lower response rates (Murray et al., 2015). Kose et al. (2018) reviewed the effectiveness of CBT for individuals with ASD and comorbid OCD. They concluded that standard CBT needed to be modified to address the special needs of children with ASD, for example increased structure in the sessions, visual aids and cues and considerable parental involvement (Kose et al., 2018). Although only four of our cases also had ASD, our impression was that eCBT could provide suitable therapy for children with both OCD and ASD, as they all responded well to treatment. The average pre-treatment CY-BOCS scores for these four patients was 27 and it was 7.25 post-treatment. Three maintained their treatment gains during follow up and the fourth was not available for follow-up assessment. The eCBT components may make this treatment appealing for children with OCD and ASD. They include facilitating individual adjustments, transfer from the therapist's office to the child's home environment, more support for ERP exercises and the possibility of more frequent contact with the therapist. A recent study (Wickberg et al., 2022) explored the feasibility of an adapted iCBT protocol for 22 children and adolescents with ASD. Approximately 60% of the participants were classified as treatment responders and 50% were in remission from their OCD at the three-month follow up. These results were benchmarked against a sample of 52 patients from a specialist clinic that regularly treats individuals with comorbid OCD and ASD. This indicated that specialized in-person CBT produced significantly larger effects (Cohen's d =

2.69). Nevertheless, the study concluded that ICBT could be successfully adapted to treat OCD in youths with ASD. It also stated that it may be a viable and less resource-demanding alternative for those who do not have direct access to highly specialized treatment.

4.5. Strengths and limitations

This study had several strengths and limitations, and it should be viewed in its methodological context.

First, the findings were based on a relatively small number of participants. Another limitation was the relatively large difference in the distribution of face-to-face versus webcam sessions between patients and the eight therapists who treated the 25 patients. This may have contributed to a considerable variation in our data. In addition, as already mentioned, the study only offered eCBT on Android phones and this meant that the patients who had other phones had to borrow an Android phone from the study. This may have been inconvenient for some children.

A major strength of the study that the eCBT treatment concept was derived using well-validated eCBT manuals, namely the NordLOTS CBT and a similar Dutch treatment protocol (De Haan & Wolters, 2009; Weidle, Christensen, et al., 2014). The comparison between our eCBT and the NordLOTS CBT was a logical choice, because their samples included patients with comparable degrees of OCD severity and comorbid disorders. It should be noted that one challenge was that NordLOTS (Franklin et al., 2011; Thomsen et al., 2013), used different feasibility cut-off criteria to the consensus published by Mataix-Cols et al. (2016) that our

eCBT project used. NordLOTS defined response to treatment as a 25–35% reduction from baseline on the CYBOCS score.

Other strengths of this study included the fact that the assessments were based on reliable tools, only the BTPS was modified for the purposes of this study, and this meant that no psychometric properties were available. We adopted a multi-perspective approach that took the views of the children, parents and therapists into account. In addition, the CY-BOCS evaluations were performed by an independent evaluator and not the therapists. Another strength was the follow-up assessment at six months.

4.6. Suggestions for future research

The aim of our study was to evaluate the acceptability and feasibility of the eCBT package and to explore its preliminary effectiveness. We wish to improve the eCBT package, based on feedback from service users, and make it even more user-friendly, by reducing features that users felt were not useful. It can then be made available to other clinicians treating OCD in children and adolescents. Future research should include randomized controlled trials with large samples' sizes to further examine the effectiveness of the eCBT package.

Looking at the wider perspective, eCBT could play an important role as part of a stepped care model, which offers patients the treatment level they need. For example, some patients may benefit from cost-effective and easily accessible self-help treatments, while others need therapist-delivered CBT with various

levels of intensity and therapist involvement (Lenhard, Ssegonja, et al., 2017; Lenhard et al., 2014; Lenhard. et al., 2017). More research is needed to better identify which patients may benefit from different types of care, as this will result in more targeted treatments and a better use of healthcare resources. iCBT offers opportunities for self-guided treatment, but it can also be combined with face-to-face and webcam treatment, with varying intensity and different levels of therapist involvement. This is very important, due to the allocation of limited resources. The need for more flexible approaches to OCD treatment has also been highlighted by the COVID-19 pandemic, as access to face-to-face treatment has been limited due to national lockdowns and social distancing measures. Personalized approaches may make individually adjustable stepped care models with iCBT components the therapy of the future. This is because they enable therapists to adapt treatment schedules to individual needs and preferences. For example, this can start with self-help treatment, which only requires low healthcare resources, followed by gradually increasing therapist guided intensive treatments for non-responders. However, we still need to know which approach works best for which patients.

More research is also needed to indicate whether treatment gains obtained from novel interventions will be maintained over time. There is evidence that treatment gains from face-to-face CBT for paediatric OCD are maintained one and three years after treatment (Højgaard et al., 2017; Melin, Skarphedinsson, Thomsen, Weidle, Torp, Valderhaug, Hojgaard, et al., 2020). However, only one study has so far followed up patients for more than one year to gauge the sustainability of treatment results after iCBT (Lenhard et al., 2020).

Potential adverse effects need to be researched thoroughly. Internet security, confidentiality issues, patient safety, and encryption are important topics in any technology-related industry. Huckvale et al. (2015) noted that more attention and research needs to focus on these issues.

4.7. Conclusions

Both children and parents were satisfied with the eCBT package for paediatric OCD, and it was found to be a feasible and acceptable intervention. Opportunities to combine face-to-face and webcam treatment as part of a more personalized stepped care approach might further improve eCBT. This would enable therapists to adapt treatment schedules to individual needs and preferences. eCBT seemed to be an effective treatment that was not inferior to standard CBT. The mean reduction of the CY-BOCS scores in the eCBT group was higher than the reductions achieved for standard CBT, and this indicates that eCBT could be more effective in reducing OCD symptoms. However, this needs to be examined in larger randomized head-to-head comparisons between groups. Although e-health development and research have increased substantially over the last 10 years, the currently available evidence-base for iCBT programmes for paediatric OCD has been limited. Our study expands the evidence base.

Chapter 5: References

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Chapter 6. Papers 1 to 4.

PAPER 1

Babiano-Espinosa et al. Systematic Reviews (2019) 8:284
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Systematic Reviews

RESEARCH Open Access

Acceptability, feasibility, and efficacy of Internet cognitive behavioral therapy (iCBT) for pediatric obsessive-compulsive disorder: a systematic review

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Abstract

Background: Obsessive-compulsive disorder (OCD) is a chronic mental health disorder characterized by recurring obsessions and compulsions affecting 1–3% of children and adolescents. Current treatment options are limited by accessibility, availability, and quality of care. New technologies provide opportunities to address at least some of these challenges. This paper aims to investigate the acceptability, feasibility, and efficacy of traditional cognitive behavioral therapy with Internet cognitive behavioral therapy (iCBT) for pediatric OCD according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Method: We searched EMBASE, Medline, PsycINFO, CENTRAL, LILACS, CINAHL, and Scopus. Results include articles from 1987 to March 2018. Main inclusion criteria were patients aged 4–18, primary diagnosis of OCD, and iCBT.

Results: Of the 2323 unique articles identified during the initial search, six studies with a total of 96 participants met our inclusion criteria: three randomized controlled trials, one single-case multiple-baseline design, one open-label trial, and one case series. Four studies reported a significant decrease in OCD severity on the Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS) following iCBT, one study reported significant decrease in CY-BOCS scores for iCBT relative to waitlist, and the case series reported (some) symptom reduction in all participants. Six studies reported high rates of feasibility, and five studies reported good acceptability of iCBT.

Conclusion: At present, evidence regarding acceptability, feasibility, and efficacy of iCBT for pediatric OCD is limited. Results are promising but need to be confirmed and refined in further research.

Systematic review registration: PROSPERO CRD4201808587

Keywords: eHealth, Obsessive-compulsive disorder, Cognitive behavioral therapy, Adolescent, Child

Background

Obsessive-compulsive disorder (OCD) is a disabling mental health disorder affecting between 1 and 3% of children and adolescents [1]. OCD is characterized by disturbing recurring thoughts (obsessions) and repetitive behaviors (compulsions) [1] and is associated with significant impairment [2] and reduced quality of life [3]. Without treatment, OCD has a chronic course in about 40–60% of those affected [4, 5].

Over the last three decades, OCD has moved from an almost untreatable, life-long psychiatric disorder to a highly manageable one. Two recent meta-analyses have supported cognitive behavioral therapy (CBT) as the first-line treatment for children and adults with OCD [6, 7] and two other meta-analyses reported larger effect sizes for CBT than for selective serotonin reuptake inhibitors (SSRIs) in pediatric OCD [8, 9]. While relapse is common after cessation of medication, treatment gains from CBT appear more stable [10]. Still, CBT for pediatric OCD has

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not reached its full potential, with response rates ranging between 40 and 65% [11, 12]. In addition, stigma about mental health treatment in general and OCD in particular, limited access to high-quality CBT, and the high costs of CBT may reduce treatment uptake [13]. Sixty to 90% of adults with OCD from Western countries and China are not seeking treatment for OCD [14].

New technologies and increased access to the Internet provide unique opportunities to address some of these challenges by offering more interactive, child-appealing [15], cost-effective [16], and more easily accessible therapies [17]. Illustrating this growing trend, the National Institute of Mental Health (NIMH) in the USA created the National Advisory Mental Health Council Workgroup on Opportunities and Challenges of Developing Information Technologies on Behavioral and Social Science Research [18]. Electronic and mobile health technologies are also included in the World Health Organization (WHO) Mental Health Action Plan 2013–2020 [19]. Internet cognitive behavioral therapy (iCBT) includes therapist-guided and automated interventions that are delivered using the Internet and information-technology based on cognitive behavioral therapy [20]. A recent systematic review indicated that Internet-based treatment programs for anxiety disorders and depression were generally well received by children and their parents [15]. These iCBT programs were effective in reducing anxiety symptoms, and some proved to be as effective as face-to-face interventions [15, 16, 21]. However, the effects on depression symptoms in adolescents and young adults (12–25 years) were small [16]. Previous meta-analysis has been published on iCBT for adult OCD showing good efficacy [22, 23]. To our knowledge, no systematic review has investigated the acceptability, feasibility, and efficacy of Internet cognitive behavioral therapy (iCBT) for pediatric OCD. The present systematic review aims to bridge this gap.

Method

Search strategy

The first paper about OCD treatment involving computer technology was published in 1987 [24]. This systematic review included studies published from 1987 to March 2018. The Cochrane database was assessed to ensure that no similar systematic review had been published. We searched the seven relevant databases: EMBASE, Medline, PsycINFO, CENTRAL, LILACS, CINAHL, and Scopus. The literature search involved a combination of thesaurus and free-text terms optimized to identify references containing three main concepts: "OCD," "Internet technology-based therapy," and "children or adolescents" Internet technology. (The exact keywords can be found in Additional file 2: study protocol.) V.B., S.P., and L.B.E. conducted the initial database research. L.W. and L.B.E independently filled the data collections forms that had been developed a priori by V.B. The data collection forms included (a) general information about the study (publication type, country of origin, funding), (b) study eligibility (inclusion criteria, sample details, study design, types of intervention, reasons to exclude), (c) study characteristics (aim, design, participants, outcomes), and (d) risk of bias assessment. L.W. and L.B.E. assessed article eligibility. In case of disagreement, consensus was reached through discussion with the other group members (B.W., N.S.). Relevant conference abstracts were searched manually to reduce potential limitations of the systematic database search. Finally, relevant Cochrane reviews, the WHO trials portal (ICTRP), ClinicalTrials.gov, and Google Scholar were searched to identify additional studies (see Additional file 2 for the study protocol).

Inclusion and exclusion criteria

Inclusion and exclusion criteria were based on the "PICOS" [25] approach to review empirical studies: population, intervention, comparators, outcomes, and study design.

Inclusion criteria

Population:

- Children and adolescents aged 4–18
- Primary diagnosis of obsessive-compulsive disorder diagnosed by a psychologist or psychiatrist according to DSM or ICD criteria
- All treatment settings
- Any cultural background, ethnicity, and sex

Intervention:

- CBT with Internet technology components
- No restrictions on therapist involvement or additional treatment

Comparator:

- Studies with and without comparators
- No restrictions were set on comparators.

Outcome:

- Treatment acceptability refers to the degree to which an individual perceives a treatment protocol as appropriate, fair, and reasonable for a given population or problem and any acceptability test is accepted as an outcome [26].
- Feasibility refers to whether treatment works in practice and drop-outs are accepted as main outcome [26].

- Treatment efficacy refers to the capacity to improving health-outcomes. Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS) is accepted as the golden standard for its assessment [9].

For an overview of assessment instruments in this article, please see Additional file 3.

Study Design:

- Randomized controlled trial, blind trial, non-blind trial, adaptive clinical trial, non-randomized trial, interrupted time series design, cohort study, case-control study, and cross-sectional study published in English [27].

Exclusion criteria

Population:

- Adults
- Diagnosis of obsessive-compulsive disorder not determined by a qualified specialist (psychologist or psychiatrist) or not according to DSM or ICD criteria

Intervention:

- Other than CBT

Comparator:

- Studies with and without comparators are accepted.
- No restrictions were set on comparators.

Outcome:

- Not reporting on acceptability, feasibility, and efficacy.

Study Design:

- Qualitative study, commentary, correction, editorial letter (unless research letter reporting data), and single-case reports

Results

Search results

The initial search identified 3537 references. After removing 1214 duplicates, the search resulted in 2323 references. Of these, 2276 references were excluded after screening titles and abstracts, resulting in 47 references that were thoroughly screened. Forty-one from these 47 references were removed due to conflicts with selection criteria. Finally, six original studies were included in this systematic review (see Fig. 1 for flow diagram).

The reviewed studies included a total of 96 participants (47 girls, 49 boys) with a mean age ranging from 6.5 [28] to 14.4 years [29] (Table 1). Two studies included children aged 4–8 years [28, 30], other studies included children and adolescents aged 7–17 years [29, 31, 32, 34]. The studies were conducted in North America [28, 30, 34], Australia [31], and Europe [29, 32]. There were three randomized controlled trials (RCTs) [29, 30, 34], one open trial [32], one single-case non-concurrent multiple-baseline design [31], and one case series [28] (Table 1). Two studies recruited families seeking treatment in outpatient clinics [28, 30]. Three studies [29, 32, 34] recruited participants from outpatient clinics and used advertisements in local newspapers, websites, and radio, and one study [31] combined advertisements in local newspapers with referrals from general practitioners.

Table 1 provides a description of the iCBT interventions. All studies included psychoeducation about OCD for the patients and their parents, as well as information about the treatment procedure. Exposure and response prevention (ERP) and cognitive interventions were key components in all procedures. All studies employed experienced clinicians [28–32, 34], and five studies also used psychology students as therapists [28–30, 32, 34]. Weekly supervisions for the therapists were performed to ensure the standards of treatment procedure [28–32, 34].

Two studies by Comer and colleagues and one by Farrell and colleagues provided a specific training for their therapists [28, 30, 31]. Therapist involvement varied from minimal (with occasional indirect contact via messages or phone) [29, 32] to substantial (via frequent video-teleconferencing) [34]. Parents were actively involved in the treatment process in all studies.

Two studies by Comer et al., and one by Farrell et al., provided a specific training for their therapists [28, 30, 31]. Therapist involvement varied from minimal (with occasional indirect contact via messages or phone) [29, 32] to substantial (via frequent video-teleconferencing) [34]. Parents were actively involved in the treatment process in all studies. Comer et al. first performed a case series [28] and subsequently an RCT [30] using the same iCBT concept. In the RCT, they compared 14 weeks face-to-face family-based CBT with family-based iCBT treatment. The iCBT included video-teleconferencing and interactive computer games that were added to enhance the children's understanding of the treatment concepts. Lenhard et al. [29, 32] evaluated "Internet Project for Children", an iCBT intervention delivered via an Internet platform with psychoeducational texts, films, animations, and exercises (12 sessions), in an open trial [32] followed by an RCT [29]. During this treatment, patients had irregular asynchronous contact with a therapist through messages and occasional telephone calls.

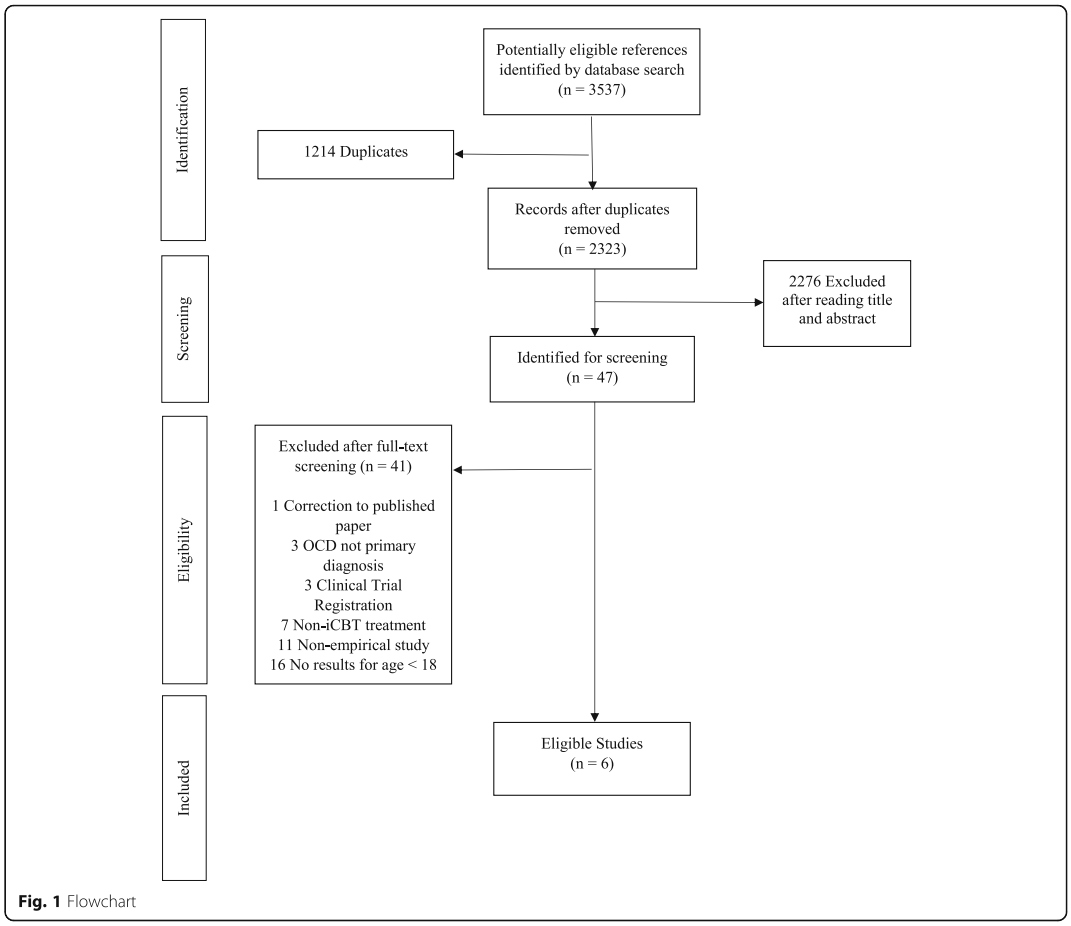

Fig. 1 Flowchart

Storch et al. [34] compared 14 CBT sessions delivered via video-teleconferencing with a waitlist control. Their iCBT program followed the Pediatric OCD Treatment Study (POTS) protocol with some adaptations, such as using email to send homework instructions [35]. Farrell et al. [31] evaluated a 6-week intensive treatment program combining iCBT and face-to-face CBT. This intervention included a 1-h face-to-face psychoeducation session and two face-to-face intensive exposure and response prevention (ERP) sessions in 2 weeks, followed by a 3-week maintenance program delivered via video-teleconferencing.

Acceptability

Acceptability was examined using validated self-report questionnaires, such as the Client Satisfaction Questionnaire (CSQ) and the Working Alliance Inventory (WAI) [28, 30], and several newly developed questionnaires (Tables 2 and 3) [29, 30, 32].

In the open trial by Lenhard et al., [32] treatment acceptability was evaluated in adolescents and at least one parent. The Internet Project for Children was rated as good or very good by the families [32]. In the following RCT, only adolescents' views were assessed [29]. Results showed that 46% of the adolescents were satisfied with the Internet Project for Children, 50% were satisfied most of the time but would have liked to meet a clinician occasionally (contact with a therapist was established through e-mail messages and phone calls only), and 4% would have preferred face-to-face treatment [29]. Other studies assessed parents' views only [28, 34]. In both studies by Comer et al., all mothers [28, 30] reported good alliance with the therapist and that they were satisfied with the treatment. Storch et al. [34] reported very high satisfaction with treatment rated by parents. One study did not report on acceptability [31].

Table 1 Overview of the eligible studies on iCBT for pediatric OCD

Reference	Study design	Control group	Participants	Parent involvement	Communication methods	Therapist involvement	Intervention		Outcome	
							Intervention contents	Intervention duration	Primary outcomes	Time of assessment
Comer et al. (USA) [28]	Case series	Not Applicable	Children aged 4-8 (*M* = 6.5; SD = 0.9) 3 boys 2 girls	(a) Parents were trained as coaches, (b) treatment addresses parental accommodation of child symptoms, and (c) treatment had an exposure component for parents.	Video-teleconference sessions	Regular contact through video-teleconference	"Internet-delivered Family-based -CBT": -Video teleconferencing -Interactive computer games, feeling thermometer, exposure hierarchy and exercises	12 sessions in 14 weeks	Treatment efficacy, feasibility, and acceptability	Baseline, post-treatment
Comer et al. (USA) [30]	RCT	Family-based CBT delivered in clinic	Children aged 4–8 (*M* = 6.7; SD = 1.3) 6 boys 5 girls	(a) Parents were trained as coaches, (b) treatment addresses parental accommodation of child symptoms, and (c) treatment had an exposure component for parents.	Video-teleconference sessions	Regular contact through video-teleconference	"Internet-delivered Family-based -CBT": -Video teleconferencing -Interactive computer games, feeling thermometer, exposure exercises and hierarchy	12 sessions in 14 weeks	Treatment efficacy, feasibility, and acceptability	Baseline, post-treatment, 6-month follow up
Farrell et al. (Australia) [31]	Single-case, non-concurrent multiple-baseline design	Not Applicable	Adolescents aged 11–16 (*M* = 13.6; SD = 1.8) 6 boys 4 girls	Parents were involved in education session, at the end of their child's intensive face-to-face sessions, and during all e-therapy maintenance sessions.	One face-to-face education session, two intensive face-to-face CBT sessions, therapy maintenance sessions via video-teleconferencing	Regular contact through video-teleconferencing	Two intensive face-to-face CBT sessions followed by e-therapy maintenance	Psychoeducation and 2 intensive CBT sessions during 3 weeks, followed by a 3-week therapy maintenance program	Treatment efficacy and feasibility	Pre-intervention, weekly assessments during 1- or 2-week baseline period, post-CBT, 1-month follow up (after e-therapy), 6-month follow up
Lenhard et al. (Sweden) [32]	Open trial	Not Applicable	Adolescents aged 12–17 (M = 14.4; SD = 2.6) 8 boys 13 girls	Parents participated in treatment through parent-specific chapters, with varying degrees of parental involvement depending on the child's age.	"Internet Project for Children": a self-help protocol through an Internet platform containing texts, films, animations and exercises; telephone calls or messages	Occasional contact through telephone calls or messages to a therapist	"Internet Project for Children" Internet platform for educative texts, films, and exercises	12 treatment chapters in 12 weeks	Treatment efficacy, feasibility, and acceptability	Baseline, 3-month, post-treatment, 6-month follow up
Lenhard et al. (Sweden) [29, 33]	RCT	Waitlist	Adolescents aged 12-17 (*M* = 14.2; SD = 1.7)	Parents participated in the treatment through parent-specific chapters, with varying degrees of	"Internet Project for Children": a self-help protocol through an Internet platform	Occasional contact through telephone calls or messages to	"Internet Project for Children" Internet platform for	12 treatment chapters in 12 weeks	Treatment efficacy, feasibility, and	Baseline, post-treatment, 3-month follow up

Table 1 Overview of the eligible studies on iCBT for pediatric OCD *(Continued)*

Reference	Study design	Control group	Participants	Parent involvement	Communication methods	Therapist involvement	Intervention		Outcome	
							Intervention contents	Intervention duration	Primary outcomes	Time of assessment
			16 boys 17 girls	parental involvement depending on the child's age	containing texts, films, animations and exercises; telephone calls or messages. Smartphone application support for ERP exercises	a therapist	educative texts, films, and exercises		acceptability	
Storch et al. (USA) [34]	RCT	Waitlist	Children and adolescents between 7 and 16 ($M = 11.1$; SD = 2.6) 10 boys 6 girls	Parents were instructed on coaching their child through exposure.	Video-teleconference sessions, email	Regular contact through video-teleconference	Web camera-delivered cognitive behavioral therapy (video-teleconference)	14 sessions in 12 weeks	Treatment efficacy, feasibility, and acceptability	Baseline, post-treatment

RCT randomized controlled trial, *CBT* cognitive behavioral therapy, *iCBT* Internet cognitive behavioral therapy

Table 2 Outcomes of acceptability, feasibility, and efficacy (non-randomized controlled trials)

Reference	Measure	Pre-treatment M (SD)	Post-treatment M (SD)	Within group Significance Pre-post	Within group Size effect (d) Pre-post	Follow-up M (SD)
Comer et al. (USA) [28]			**Efficacy**			
	CY-BOCS	24.2 (5.2) [c]	17.4 (5.9) [c]	Not Reported	2.54	Not Applicable
	ADIS-IV-C/P (OCD CSR)	6.2 (1.1) [c]	4.0 (1.4) [c]	Not Reported	5.88	Not Applicable
	CGAS	51.8 [d]	58.6 [d]	Not Reported	2.87	Not Applicable
	CGI-S	5.2 [d]	3.6 [d]	Not Reported	Not Reported	Not Applicable
	CGI-I	Not Applicable	2.2 (0.8) [c]	Not Reported	Not Reported	Not Applicable
			Acceptability			
	CSQ-8 (First Item)	Not Applicable	All mothers rated quality as "Excellent"	Not Applicable	Not Applicable	Not Applicable
			Feasibility			
	Treatment dropout	Not Applicable	Dropout = 0	Not Applicable	Not Applicable	Not Applicable
Farrell et al. (Australia) [31]			**Efficacy**			
	CYBOCS	29.1 (4.2)	14.8 (7.7)	p< 0.001	2.09	11.8 (8.9) [b]
	CY-BOCS-SR (Parent)	24.1(3.3)	12.9 (7.3)	p< 0.001	1.94	11.5 (9.5) [b]
	ADIS-IV-C/P (OCD CSR)	6.6 (0.5)	3.5 (2.0)	p< 0.001	2.28	3.3 (1.9) [b]
	NIMH GOCS	10.7 (1.8)	6.3 (3.1)	p< 0.005	1.36	5.8 (3.6) [b]
	CGI-S	5.6 (0.5)	3.1 (1.5)	p< 0.001	2.25	2.7 (1.6) [b]
	CDI-S	13.6 (10.9)	10.3 (7.9)	p< 0.05	0.34	Not Reported
	MASC	83.6 (35.0)	60.1 (26.1)	p= n.s.	0.76	Not Reported
	PEDSQL	35.3 (12.1)	18.5 (14.9)	p< 0.05	1.23	Not Reported
			Feasibility			
	Treatment dropout	Not Applicable	Dropout = 0	Not Applicable	Not Applicable	Not Applicable
Lenhard et al. (Sweden) [32]			**Efficacy**			
	CY-BOCS	21.3 (3.5)	12.1 (4.5)	p< 0.001	2.29	8.8 (5.1) [a] 9.1 (6.4) [b]
	ChOCI –symptom Parent	12.4 (6.8)	6.5 (5.1)	p< 0.001	0.94	5.3 (5.6) [a] 4.5 (4.3) [b]
	ChOCI –impairment Parent	24.9 (7.0)	17.8 (10.0)	p< 0.001	0.79	12.4 (8.1) [a] 11.5 (6.4) [b]
	ChOCI –symptom child	13.6 (8.7)	6.4 (6.6)	p< 0.001	0.92	5.3 (6.7) [a] 5.0 (6.6) [b]
	ChOCI – impairment	22.6 (8.1)	11.6 (6.3)	p< 0.001	1.51	9.9 (8.9) [a]

Table 2 Outcomes of acceptability, feasibility, and efficacy (non-randomized controlled trials) *(Continued)*

Reference	Measure	Pre-treatment M (SD)	Post-treatment M (SD)	Within group Significance Pre-post	Within group Size effect (d) Pre-post	Follow-up M (SD)
	child					10.4 (9.1) [b]
	COIS-R Parent	25.3 (16.1)	16.8 (17.2)	p< 0.05	0.45	13.0 (15.7) [a] 13.9 (15.0) [b]
	COIS-R Child	17.3 (15.5)	6.6 (7.9)	p< 0.001	0.88	5.2 (8.4) [a] 6.0 (9.0) [b]
	CGI-I	Not Applicable	52% "Much Improved" or "Very Much Improved"	Not Applicable	Not Applicable	71 % "Much Improved" or "Very Much Improved" [a] [b]
	CGAS	56.1 (6.3)	71.5 (9.3)	p< 0.001	-1.94	74.0 (9.0) [a] 73.5 (9.7) [b]
	CDI-S	9.6 (1.4)	9.9 (1.2)	p= n.s.	-0.19	2.5 (2.7) [a] 2.2 (2.1) [b]
	FAS	14.6 (8.4)	9.6 (7.1)	p<0.05	0.60	6.9 (8.1) [a] 6.5 (6.9) [b]
	SDQ Parent	12.0 (6.7)	10.3 (6.3)	p= n.s.	0.29	10.3 (6.6) [a] 9.7 (6.4) [b]
	SDQ child	13.5 (5.5)	10.6 (4.0)	p= n.s.	0.61	10.7 (4.2) [a] 10.5 (4.8) [b]
	SCAS without OCD Parent	25.2 (15.7)	16.0 (13.5)	p<0.001	0.63	16.4 (12.2) [a] 15.7 (14.1) [b]
	SCAS OCD Child	9.1 (5.0)	4.1 (3.4)	p<0.001	1.17	2.9 (3.8) [a] 3.3 (4.0) [b]
	SCAS without OCD Child	30.4 (16.9)	20.2 (13.5)	p<0.001	0.67	18.9 (14.0) [a] 18.3 (14.2) [b]
			Acceptability			
	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
			Feasibility			
	Treatment dropout	Not Applicable	8.3/12 Chapters completed by patients (3.0) 4.7/5 Chapters completed by parents (0.8)	Not Applicable	Not Applicable	Not Applicable

[a]for 3 months; [b] for 6 months; [c] mean and standard deviation calculated by the reviewer; [d] standard deviation and data required for calculating SD not provided

Table 3 Outcomes of acceptability, feasibility, and efficacy (randomized controlled trials)

Reference	Measure	Pre-treatment M (SD)	Post-treatment M (SD)	Between groups Significance (WL-CBT)	Between groups Significance (iCBT-CBT)	Within group Significance PRE-POST	Between groups Effect size (d)	Follow-up M (SD)
Comer et al. (USA) [30]				**Efficacy**				
	CY-BOCS	22.9 (4.1)	14.9 (7.3)	Not Applicable	p=n.s	Not Reported [c]	0.09	11.8 (9.5) [b]
	ADIS-IV-C/P (OCD CSR)	5.1 (0.8)	3.4 (1.2)	Not Applicable	p=n.s	Not Reported [c]	0.24	2.4 (2.6) [b]
	CGI-S	4.9 (0.7)	3.2 (1.5)	Not Applicable	p=n.s	Not Reported [c]	-0.06	2.6 (2.5) [b]
	CGAS	48.0 (8.0)	61.4 (12.0)	Not Applicable	p=n.s	Not Reported [c]	-0.06	66.6 (15.9) [b]
	FAS	29.5 (7.8)	19.5 (9.7)	Not Applicable	p=n.s	Not Reported [c]	0.56	15.6 (14.2) [b]
				Acceptability				
	CSQ-8	Not Applicable	Mother 28.6 (4.5)	Not Applicable	p=n.s.	Not Applicable	Not Applicable	Not Applicable
	WAI	Not Applicable	Mother 223.5 (34.8) Therapist 226.1 (32.9)	Not Applicable	p=n.s. p=n.s.	Not Applicable	Not Applicable	Not Applicable
				Feasibility				
	Treatment drop-out	Not Applicable	Dropout = 1	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Lenhard et al. (Sweden) [29, 33]				**Efficacy**				
	CY-BOCS	23.0 (4.3)	17.0 (6.3)	p<0.001	Not Applicable	Not Reported	0.69	14.2 (5.9) [a]
	ChOCI-R child	24.5 (6.7)	20.0 (7.8)	p=0.014	Not Applicable	Not Reported	0.64	19.3 (8.3) [a]
	ChOCI-R parent	24.4 (7.6)	19.3 (9.9)	p=0.012	Not Applicable	Not Reported	0.59	17.7 (8.7) [a]
	CDI	4.7 (3.4)	4.6 (4.0)	p=n.s.	Not Applicable	Not Reported	-0.01	4.7 (4.2) [a]
	SCAS parent	10.7 (5.8)	8.3 (5.9)	p=0.004	Not Applicable	Not Reported	0.67	8.4 (5.6) [a]
	SCAS child	12.9 (6.4)	11.4 (7.4)	p=n.s.	Not Applicable	Not Reported	0.27	10.4 (6.4) [a]
	EWSAS child	14.8 (9.2)	12.8 (9.7)	p=n.s.	Not Applicable	Not Reported	0.27	10.7 (9.1) [a]
	EWSAS parent	16.1 (8.6)	11.4 (8.5)	p<0.001	Not Applicable	Not Reported	0.43	11.1 (9.2) [a]
	FAS	15.8 (11.3)	11.2 (9.2)	p=0.003	Not Applicable	Not Reported	0.54	10.6 (10.2) [a]
				Acceptability				
	Self-made questionnaire	Not Applicable	46% of the patients were satisfied with internet- delivered format, 50% would have liked to meet a clinician 4% would have preferred face-to-face treatment Patients' treatment rating: 32% Very Good, 32% Good 36% Ok, 0% Bad	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Table 3 Outcomes of acceptability, feasibility, and efficacy (randomized controlled trials) *(Continued)*

Reference	Measure	Pre-treatment M (SD)	Post-treatment M (SD)	Between groups Significance (WL-CBT)	Between groups Significance (iCBT-CBT)	Within group Significance PRE-POST	Between groups Effect size (d)	Follow-up M (SD)
				Feasibility				
	Treatment drop-out	Not Applicable	8.5/12 chapters completed (2.9) Dropout = 1	Not Applicable	Not Applicable	Not Applicable		Not Applicable
Storch et al. (USA) [34]				**Efficacy**				
	CY-BOCS	25.4 (3.6)	11.1 (10.5)	p<0.001	Not Applicable	Not Reported	1.36	11.3 (9.4) [a]
	COIS Parent	42.8 (23.4)	16.8 (24.5)	p=0.005	Not Applicable	Not Reported	0.99	Not Reported
	COIS child	38.8 (24.1)	16.1 (19.0)	p=0.03	Not Applicable	Not Reported	0.46	Not Reported
	CGI-S	3.8 (0.9)	1.6 (1.8)	p<0.001	Not Applicable	Not Reported	1.48	1.4 (1.3) [a]
	CGI-I	Not Applicable	13/16 participants (81%) responder (a ≥30% reduction in CY-BOCS score and a CGI-I score of 1 or 2)	p<0.001	Not Applicable	Not Reported	Not Applicable	Not Reported
	CDI	8.9 (6.7)	7.5 (8.0)	p=n.s.	Not Applicable	Not Reported	0.43	Not Reported
	MASC	39.9 (14.8)	33.4 (14.8)	p=n.s.	Not Applicable	Not Reported	0.46	Not Reported
	FAS	25.7 (8.6)	16.1 (13.9)	p=0.003	Not Applicable	Not Reported	0.37	Not Reported
				Acceptability				
	PWA	Not Applicable	19.4 (1.3) Parents' Satisfaction	Not Applicable	Not Applicable	Not applicable	Not applicable	Not Applicable
				Feasibility				
	Treatment drop-out	Not Applicable	Dropout = 2	Not Applicable	Not Applicable	Not applicable	Not applicable	Not Applicable

Feasibility

We examined treatment feasibility by documenting drop-out from treatment, which ranged from none [28, 31] to two patients across all studies [34] (Tables 2 and 3). Altogether, 4.2% (four patients) dropped-out from all treatments. No participants dropped out from treatment in the case series study by Comer et al. [28], nor in the study by Farrell et al. [31]. One patient dropped out in the RCT by Comer et al. [30] (after session one; reason not reported). In Storch and colleagues' study [34], two participants withdrew from treatment due to a lack of perceived benefit. In the RCT from Lenhard et al. [29], one treatment drop-out was reported.

Efficacy

All studies used the Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS) [36] to assess the severity of OCD symptoms (Tables 2 and 3). Four studies reported a statistically significant decrease in CY-BOCS scores from pre- to post-treatment [30–32, 34]. Comer et al. [28] reported that three of the five participants had a post-treatment CY-BOCS score < 16 (clinical cut off), two other participants showed minimal improvement. Lenhard et al. reported a significant improvement in CY-BOCS score after iCBT [29]. Comer et al. [30] reported no significant difference between face-to-face CBT and iCBT.

Storch et al. [34] reported more than a half reduction (56.1%) in OCD symptoms on the CY-BOCS following iCBT. Lenhard et al. [29, 32] reported an average reduction of 41% and 26%[1] in CY-BOCS scores following iCBT in their open trial and RCT, respectively. Results from the study by Farrell et al. [31] showed 49%[1] symptom reduction at post-treatment. Comer et al. reported a 35%[1] and 28%[1] average reduction in CY-BOCS scores at post-treatment in their RCT [30] and case series [28], respectively. In addition, four studies reported improvements at post-treatment on the Children's Global Assessment Scale (CGAS) [37] and the Clinical Global Impression Scale (CGI) [38] (Tables 2 and 3, see Additional file 3 for assessment glossary) [28, 30, 31, 34].

In their open trial, Lenhard et al. reported significant improvement at 3-month follow-up, which was maintained at 6-month follow-up [32]. In their RCT, participants continued to show significant improvement from post-treatment to 3-month follow-up [29]. Comer et al. reported significant improvement from pre-treatment to 6-month follow-up [30]. Farrell et al. reported 8 of 10 children in "reliable change" with at least 8.33 points in symptoms improvement on the CY-BOCS at post-treatment and 6-month follow-up (Tables 2 and 3) [31].

[1]Percentages based on group differences between mean pre- and mean post-treatment score.

Risk of bias

As recommended by the Cochrane Collaboration, we used the Cochrane Collaboration's tool to assess risk of bias (low, unclear, or high-risk) among the eligible studies [39]. Overall results showed some risk of bias [39]. This was mainly due to the fact that even in the studies where a random generator was used to allocate participants to treatment condition, the need for the use of devices in the experimental condition (iCBT treatment), may be problematic for blinding participants to treatment condition [29, 30, 34]. As a consequence of this, there may be an unclear risk bias in the blinding of outcomes category [28–32, 34] (Table 4).

Discussion

To our knowledge, this is the first systematic review on the acceptability, feasibility, and efficacy of iCBT for pediatric OCD. We identified six eligible studies involving four different iCBT interventions for pediatric OCD with a total number of 96 subjects.

The last decade has seen a substantial increase in e-mental health development and research [40]. The low number of eligible studies for pediatric OCD is in striking contrast to the rising use of Internet and mobile devices all over the world [41], their extensive use during childhood and adolescence [42], and the rising interest in iCBT [19]. There are more studies on iCBT in other populations than pediatric OCD. In 2015, a meta-analysis on iCBT for adult OCD included eight RCTs ($N = 420$) and reported no significant difference in efficacy between iCBT and face-to-face cognitive behavioral therapy [22]. In 2016, another meta-analysis included 18 studies and results showed large effect sizes for remote treatment for OCD in adults [23]. These results are in line with the results that we found in the present review. Furthermore, a recent meta-analysis on smartphone applications for depressive symptoms in adults [43] identified 18 RCTs assessing 22 smartphone applications, compared to only one smartphone application in our review [29]. Results of the present review showed that high treatment acceptability was reported in the five studies where acceptability was assessed [28–30, 32, 34]. However, different assessment tools were used (i.e., CSQ-8, PWA, WAI, self-developed questionnaires), and acceptability assessment tools were not always standardized or validated [29, 32]. Albeit opinions regarding treatment can differ considerably between respondents, some studies assessed only mothers' acceptance of the treatment [28, 30], some studies reported parents' acceptance (not specifying which parent) [32, 34], some studies assessed working alliance evaluated by the therapist [30], and only two studies assessed children's

Table 4 Risk of bias assessment

		Random sequence generation bias (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias) Patient-reported outcomes	Blinding of outcome assessment (detection bias) Evaluator-reported outcomes	Incomplete outcome data (attrition bias) Post-treatment	Incomplete outcome data (attrition bias) Follow-up	Selective reporting (reporting bias)
Comer et al. (USA) [28]	Non-RCT	Not applicable	Not applicable	Not applicable	Unclear risk	Low risk	Low risk	Not applicable	Low risk
Comer et al. (USA) [30]	RCT	Low risk	Low risk	Unclear risk	Unclear risk	Low risk	Low risk	Low risk	Unclear risk
Farrell et al., 2016 (Australia) [31]	Non-RCT	Not applicable	Not applicable	Not applicable	Unclear risk	Low risk	Low risk	Low risk	Low risk
Lenhard et al., 2014 (Sweden) [32]	Non-RCT	Not applicable	Not applicable	Not applicable	Unclear risk	Unclear risk	Low risk	Low risk	Low risk
Lenhard et al., 2017 (Sweden) [29, 33]	RCT	Low risk	Low risk	Unclear risk	Unclear risk	Low risk	Low risk	Low risk	Low risk
Storch et al., 2011 (USA) [34]	RCT	Low risk	Low risk	Unclear risk	Unclear risk	Unclear risk	Low risk	Low risk	Low risk

acceptance [29, 32]. Although acceptability was generally rated to be high in the study by Lenhard et al., [29] where therapist contact consisted of occassional e-mail, messages, and phone calls, half of participants reported that they would have liked to meet with a clinician occasionally, indicating that face-to-face therapist contact was an unmet need for part of this sample. In general, the findings in the present review regarding treatment acceptance are in line with the high acceptance of iCBT found for children with depression and anxiety [15]. Overall, thus far systematic reviews about Internet interventions for pediatric anxiety, depression, and internalizing problems have focused mainly on efficacy, and acceptability is generally under-reported [16, 21, 44].

Based on the low number of treatment drop-outs, ranging from none [28, 31, 32] to two individuals [29, 30, 34], feasibility was found to be high in all eligible studies. This is in line with two systematic reviews that reported good feasibility of Internet-assisted delivery of CBT for childhood anxiety and of web-based interventions for youth with internalizing problems [15, 44]. However, these results should be interpreted with caution due to the small samples of the included studies.

All studies reported favorable effects of iCBT on OCD symptoms. The reported efficacy of iCBT in the reviewed studies ranged between 26%[1] [29] and 56%[1] OCD symptom reduction [34]. A possible explanation for the variety in treatment effect is that development and application of iCBT programs are driven by different strategies. One strategy aims to overcome geographic barriers [34], other studies seek to improve limited response rates of conventionally delivered face-to-face CBT [28, 30, 31, 34], while another strategy aims to offer low-cost and easily accessible autonomous treatment programs [29, 32]. The heterogeneous results regarding efficacy should be interpreted according to the scope of the intervention.

Preliminary results indicate that treatment gains are maintained over time (3–6 months) [30–32]. While there is some evidence that treatment gains from face-to-face CBT on pediatric OCD are maintained at 1-year follow up [10], evidence concerning the sustainability of treatment results of iCBT is currently very limited.

None of the eligible studies reported a worsening of symptoms or any other treatment-related adverse events during iCBT. These results tentatively suggest that iCBT is a safe treatment. However, the spiraling growth of non-evidence-based e-health applications with poor guidance for users on how to make their choice causes concern [45]. Several potentially harmful effects, for example, regarding Internet security, confidentiality issues, and patient safety [46] were not assessed. This is a serious risk. A systematic review of Huckvale et al. [46] discovered systematic gaps for data security in 89% of the accredited health apps.

The main limitation of the current systematic review is the low number of eligible studies and their small samples [28–32, 34]. The six eligible studies came from three different continents (North America, Europe, and Australia) representing some cultural diversity although all belong to western cultures. As a result to our wide acceptance criteria, internal validity might be threatened [47]. There was a wide range of differences among the interventions, including the format of the intervention, the kind of Internet technology that was used, the length of treatment, and the amount of therapist contact. These differences make it difficult to draw an overall conclusion regarding the use of iCBT for pediatric OCD. However, the use of wide criteria made it possible to provide a complete overview of the state of the art in this field. In addition, wide inclusion criteria strengthened the external validity of this review, since the results show a realistic picture of the variety of iCBT treatments for pediatric OCD. A meta-analysis was not performed due to the small samples in the included studies, the low number of RCTs, and heterogeneity among treatments. Among the RCT's, two were superiority trials with waitlist as control group [29, 34], and one was a non-inferiority trial with traditional face-to-face CBT as control group [30]. The two superiority trials [29, 34] examined very different iCBT treatments. One treatment consisted of a self-help program with minimal contact with the therapist [29]. The other treatment was based on regular contact with a therapist through video-teleconferencing [34]. These treatments aim to meet different needs for different patients. For these reasons, we believe that the results should be considered into the context of the treatments. Strengths of the present systematic review include the use of PRISMA guidelines to summarize and discuss the current state of acceptability, feasibility, and efficacy of iCBT for pediatric OCD (Additional file 1). These findings have importance for future directions. They do also raise questions requiring further research.

iCBT includes potential benefits offering CBT in a format that allows for reduced stigma and more widely available and accessible care. In addition, to meet the young patients in their area of expertise and using their "language" and way of cultural expression may enhance motivation for and adherence to the treatment program, which may contribute to more effective treatment and a reduced number of treatment drop-out. Studies exploring cost-effective and easy accessible autonomous treatment programs with minimal therapist contact are highly interesting in the scope of a stepped care model, allowing to differentiate between patients who benefit from this type of low-cost treatments and those who

need therapist-delivered CBT [29, 32, 33]. In addition, intensive treatments, that could be delivered in varying formats, may be needed for other patients. A broader understanding about which format and amount of intervention works best for whom may lead to better outcomes and reduced societal costs. Future studies could focus on this question, assessing how different iCBT formats can augment traditional CBT by meeting the individual needs of patients. In addition, we need to know whether treatment gains obtained from these interventions will be maintained over time. It is also essential to assess and monitor potential adverse effects, for example, regarding Internet security, confidentiality issues, patient safety, and encryption. The use of smartphones, video-games, or health wearable trackers has the potential to both address barriers for treatment by adapting the therapy to the modern every-day life of the patient and to provide new possibilities for improved cost-effectiveness. However, the currently available scientific-evidence must improve substantially to enable the broader use of these new technologies.

Conclusion

Although e-mental health development and research have increased substantially over the last 10 years, the currently available evidence-base for iCBT programs for pediatric OCD is limited. The results in this systematic review indicate that iCBT can be a feasible and acceptable treatment. Available limited evidence supports the use of i-tools to enhance ERP exercises and overcome barriers to treatment. However, replication studies with bigger samples are needed, along with studies testing which modalities and components for iCBT are most effective for whom.

Supplementary information

Supplementary information accompanies this paper at https://doi.org/10.1186/s13643-019-1166-6.

Additional file 1. PRISMA 2009 checklistR1.

Additional file 2. Study protocol.

Additional file 3. Overview of assessment instruments.

Abbreviations

CBT: Cognitive behavioral therapy; CENTRAL: The Cochrane Central Register of Controlled Trials; CGAS: Children's Global Assessment Scale; CGI: Clinical Global Impression Scale; CINAHL: Cumulative Index of Nursing and Allied Health Literature; CSQ-8: The Client Satisfaction Questionnaire-8; CY-BOCS: Children's Yale-Brown Obsessive-Compulsive Scale; DSM: The Diagnostic and Statistical Manual of Mental Disorders; EMBASE: Excerpta Medica dataBASE; ERP: Exposure and response prevention; iCBT: Internet cognitive behavioral therapy; ICD: International Statistical Classification of Diseases and Related Health Problems; ICTRP: International Clinical Trials Registry Platform; LILACS: Latin American and Caribbean Health Sciences Literature; NIMH: National Institute of Mental Health; OCD: Obsessive Compulsive Disorder; PICOS: Population, intervention, comparators, outcomes, and study design; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PWA: Parent Working Alliance; RCT: Randomized controlled trial; SSRIs: Selective serotonin reuptake inhibitors; WAI: Working Alliance Inventory; WHO: World Health Organization

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Authors' contributions

LBE contributed to the acquisition, analysis, and interpretation of data for the work (assessing independently the identified trials to determine eligibility, risk of bias assessment) and drafting of the work. LW contributed to the conception and design of the work and the acquisition, analysis, and interpretation of data for the work (assessing independently the identified trials to determine eligibility and risk of bias assessment), revising the work critically for important intellectual content. BW contributed to the design of the work, revising the work critically for important intellectual content. VB contributed to the conception and design of the work (protocol drafting) and the acquisition, analysis, interpretation of data for the work (preliminar searches), revising the work critically for important intellectual content. SP contributed to the acquisition and analysis (database searches), revising the work critically for important intellectual content. SC contributed to the design of the work, revising the work critically for important intellectual content. NS contributed to the conception and design of the work and the acquisition, analysis, and interpretation of data for the work (assessing independently the identified trials to determine eligibility and risk of bias assessment), revising the work critically for important intellectual content. All authors agree both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature. All authors approved of the final version to be published.

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Competing interests

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Publisher's Note

PAPER 2

Protocol

Feasibility, Acceptability, and Effectiveness of Enhanced Cognitive Behavioral Therapy (eCBT) for Children and Adolescents With Obsessive-Compulsive Disorder: Protocol for an Open Trial and Therapeutic Intervention

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Abstract

Background: Although the evidence base of cognitive behavioral therapy (CBT) for pediatric obsessive-compulsive disorder (OCD) has been broadly established, the treatment is hampered by limited access, poor compliance, and nonresponse. New technologies offer the opportunity to improve the accessibility, user friendliness, and effectiveness of traditional office-based CBT. By employing an integrated and age-appropriate technologically enhanced treatment package, we aim to execute a more focused and attractive application of CBT principles to increase the treatment effect for pediatric OCD.

Objective: The aim of this open study is to explore the acceptability, feasibility, and effectiveness of a newly developed enhanced CBT (eCBT) package for pediatric OCD.

Methods: This study is an open trial using a historical control design conducted at the outpatient clinic of the Department of Child and Adolescent Psychiatry at St. Olavs University Hospital (Trondheim) or at BUP Klinikk (Aalesund). Participants are 30 children (age 7-17 years) with a primary Diagnostic and Statistical Manual of Mental Disorders (DSM)-5 diagnosis of OCD, and their parents. All participants receive eCBT. eCBT consists of the usual evidence-based CBT for pediatric OCD in an "enhanced" format. Enhancements include videoconferencing sessions (supervision and guided exposure exercises at home) in addition to face-to-face sessions; an app system of interconnected apps for the child, the parents, and the therapist; psychoeducative videos; and frequent online self-assessments with direct feedback to patients and the therapist. Primary outcome measures are the Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS) (effectiveness), the Client Satisfaction Questionnaire-8 (acceptability), and treatment drop out (feasibility). Assessments are conducted pretreatment, posttreatment, and at 3- and 6-month follow-ups. A 12-month follow-up assessment is envisioned. The treatment outcome (CY-BOCS) will be compared to traditional face-to-face CBT (data collected in the Nordic Long-term OCD Treatment Study).

Results: Ethical approval has been obtained (2016/716/REK nord). Inclusion started on September 04, 2017. Data collection is ongoing.

Conclusions: This study is the first step in testing the acceptability, feasibility, and preliminary effectiveness of eCBT. In case of positive results, future steps include improving the eCBT treatment package based on feedback from service users, examining cost-effectiveness in a randomized controlled trial, and making the package available to clinicians and other service providers treating OCD in children and adolescents.

Trial Registration: ISRCTN, ISRCTN37530113; registered on January 31, 2020 (retrospectively registered); https://www.isrctn.com/ISRCTN37530113.

International Registered Report Identifier (IRRID): DERR1-10.2196/24057

(JMIR Res Protoc 2020;9(12):e24057) doi: 10.2196/24057

KEYWORDS

obsessive-compulsive disorder; cognitive behavioral therapy; e-mental health; children; adolescents; cognitive; behavioral; pediatric

Introduction

Background

Pediatric obsessive-compulsive disorder (OCD) is a relatively common, severe, and debilitating condition [1], leading to substantial impairment in family, academic, and social functioning [2,3] and reduced quality of life [4]. Cognitive behavioral therapy (CBT) is the treatment of choice [5,6], and its effectiveness has been extensively demonstrated [7-9]. However, treatment for pediatric OCD is limited by several problems.

First, not all children benefit sufficiently from treatment. In general, after standardized CBT, average symptom improvement is about 50%, with large individual differences [10,11]. The combination of CBT with pharmacotherapy is an option for partial responders and nonresponders, but recent studies have cast doubts on the additional effect of medication [12,13]. Furthermore, use of medication entails several disadvantages, such as possible adverse effects, a heightened chance of relapse by discontinuation, and unknown effects in the long term [14]. This highlights the need for new ways to improve treatment for pediatric OCD.

Second, there are organizational and practical barriers to treatment. Particularly in remote areas, CBT is not always available, and in many places, there has been a long tradition of a shortage of experienced therapists and long waitlists for treatment [15-18]. Practical problems with scheduling, treatment associated costs, disorder-specific symptoms that restrict mobility, shame, and stigma can further limit accessibility to treatment [16,19-22].

In parallel, the use of digital technology in child mental health care is rapidly increasing [23]. Technologies (computers, internet, mobile devices, and apps) offer a unique opportunity to address several limitations associated with traditional treatment, such as access, suitability, expense, and stigma. In addition, new technologies can be appealing to children and adolescents, which may increase treatment compliance and motivation.

Several types of technology-based CBT (tCBT) programs for OCD have been developed and implemented, including online bibliotherapy, online self-help therapy, therapist-supported computerized CBT, smartphone apps, traditional CBT delivered via telephone or videoconferencing, and combinations of these forms [22,24-27]. Preliminary evidence shows that these programs yield positive effects overall. A meta-analysis on tCBT for OCD, which was based on eight randomized controlled trials (N=420, including youth, n=31), showed a large effect size for tCBT (*d*=1.18, CI 0.80-1.56) [25]. Moreover, tCBT was found to be superior to control conditions (waitlist and active controls, *d*=0.82), and no difference was found in efficacy between tCBT and traditional therapist-delivered CBT [25]. Results from a recent systematic review on tCBT for pediatric OCD (N=96) indicated that tCBT can be a feasible and acceptable treatment for youth with OCD [24].

However, tCBT for OCD is still in its infancy. Current evidence is limited by small numbers of trials, small sample sizes, methodological shortcomings, and focus on adults in most studies. In addition, tCBT programs vary greatly in format, duration, intensity, length, and their specific aims, making it hard to draw firm conclusions. This stresses the need for further research, especially in children with OCD.

In this protocol, we propose an *enhanced* cognitive behavioral therapy (eCBT) package for pediatric OCD, integrating modern internet technology and traditional CBT, in order to improve treatment response as well as user friendliness.

eCBT for Pediatric OCD

eCBT is an innovative treatment package for children and adolescents with OCD, which has been developed by academic OCD experts, clinicians, information technology and media developers, and service users. eCBT integrates modern technology with well-validated principles of CBT, with the aim to address some challenges faced by traditional therapy. eCBT employs the Norwegian [28] and Dutch [29] treatment manuals for CBT for pediatric OCD. For both protocols, effectiveness has been demonstrated [11,30]. Equivalent to traditional CBT, eCBT contains psychoeducation, exposure with response prevention (ERP), cognitive interventions, and relapse prevention. Parents are actively involved in the treatment. eCBT enhances traditional CBT by offering treatment at home via a webcam in addition to face-to-face sessions, more frequent therapist contact, and an app system to support and monitor treatment. Taking into account the shortage of experienced therapists and high societal health care costs, total therapist time for eCBT is kept equivalent to traditional CBT.

Treatment Components

The following five closely linked components are integrated in the eCBT treatment process: videoconferencing sessions in combination with face-to-face sessions, an app system, a psychoeducation tool, and frequent online ratings with direct feedback to the patient. We describe these components in more detail below.

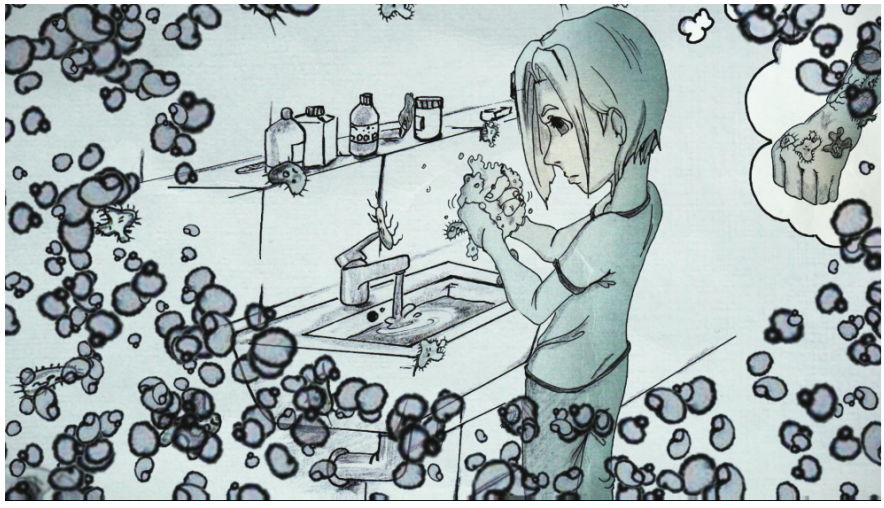
eCBT combines face-to-face treatment sessions with videoconferencing sessions from home. During the videoconferencing sessions, therapists assist children in ERP exercises at home or at other places that elicit OCD symptoms. The videoconferencing sessions aim to improve the ecological validity of the treatment and to encourage generalization of CBT principles by extending treatment from the therapist's office to settings in which the problems naturally occur. In addition, treatment at home may be more convenient and may reduce travelling time, costs, and stigma. Children and therapists have access to the video-teleconferencing software via their smartphones, using Cisco Webex Teams [31]. Face-to-face sessions, allowing for full contact, may facilitate the building of therapeutic alliance and may provide the therapist with other information since observations are not limited to the scope of the webcam.

The app system consists of a smartphone app for children, a smartphone app for parents, and a web-based application for therapists on the computer, which are all interconnected. The main goals of the app system are to increase motivation and treatment adherence, and to encourage parents' involvement in the treatment process. The app system further contributes to personalizing treatment to individual needs. The app provides information about OCD and CBT (psychoeducation videos), supports and structures ERP exercises at home, and closely monitors treatment progress. The web-based application for therapists has a coordinating and monitoring function. The app can be used in the treatment sessions together with the therapist and independently at home. Multimedia Appendix 1 provides an overview of the app system.

The app system is fully integrated in the treatment process, starting in the first session with the psychoeducation tool. The psychoeducation tool contains four video stories showing animated narratives of children with OCD. The aim is to provide information about OCD and treatment (CBT), to increase insight in an attractive and accessible way, to give recognition to a patient's struggle with OCD and take away shame, and to provide hope and motivation for treatment. The videos, displaying cartoons voiced over by a child or a parent, show how OCD has interfered in the lives of these children and their families, and show their experiences with treatment. The tone is positive and encouraging. The portraits represent children of different ages and both sexes, with different OCD symptomatology to facilitate recognition and identification with one of the portraits. Figure 1 displays a picture of one of the video stories. Multimedia Appendix 2 provides a description of the stories.

The app is also used to facilitate listing and monitoring of OCD symptoms. OCD symptoms can be entered via the therapist application during the treatment sessions or directly in the child and parent apps. Symptoms are scored on a subjective units of distress (SUD) scale. The three symptoms identified by the child and parents as most important are marked, forming the *top problems* measure that is used for idiographic patient-guided assessment of treatment progress [32]. Parents can make a list of the child's symptoms from their perspective, for example, in case of young children who are not able to list the symptoms themselves and in the case of different views on the symptoms between parents and the child. This approach allows the therapist to get a more complete picture of the OCD and keep parents involved, and it may facilitate discussion when the child and parents disagree, opening the way to a shared vision.

Figure 1. Psychoeducation tool.



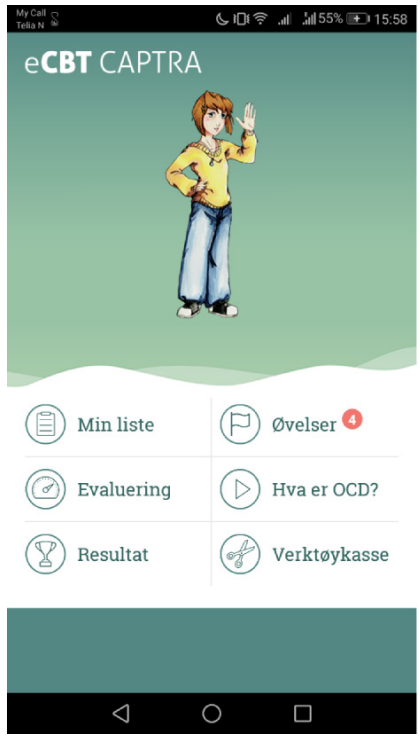
The app further contains a feature to structure and support ERP exercises at home. During the treatment sessions, ERP exercises are described in the app and can be displayed at any moment in the child and parent versions of the app. The child can receive daily reminders for the ERP exercises. When the child activates an ERP exercise in the app, the description of the exercise appears, followed by a button to confirm the start and end of the exercise, and finally, an evaluation question ("How much discomfort did you have during the exercise?"; visual analog scale [VAS]). The app contains a virtual reward system for the

number of completed ERP exercises to keep the child motivated. The description of the ERP exercises in the parents' app keeps parents informed and may facilitate parents to support the exercises. Therapists can add, modify, and monitor exercises via the therapist application.

The child can build a personal support and relapse prevention plan via the app. Any kind of support (ie, coping strategies and tools for dealing with distress) in overcoming OCD can be added to the "toolbox" in the form of text, images, pictures, and video and audio files. The toolbox is a working file that is continuously supplemented and refined throughout the treatment. At the end of the treatment, an individualized relapse prevention plan is added to the toolbox. This plan can be exported to a PDF file, allowing for a paper version of the plan as well.

The child and parents are encouraged to daily rate OCD severity and overall psychological well-being using short idiographic ratings in the app with direct feedback to the patient and the therapist (Multimedia Appendix 3). In addition, the three OCD-related problems identified by the child and parents as most important (*top problems* measure) are evaluated weekly in the app. Reminders can be set for completing the ratings. Results (visually displayed in graphs showing progress during the last week and last 6 months) are directly accessible via the child and parent apps, since direct feedback to patients may enhance motivation and thereby treatment effect [33]. In addition, the outcomes provide the therapist with actual information. Signs of noncompliance can be monitored regularly, and early steps can be taken to address problems. Figure 2 displays a screenshot of the app.

Figure 2. Screenshot of the app for children.



Treatment Process

eCBT covers a 14-week treatment period. The first part of the treatment (weeks 1-5) consists of weekly face-to-face sessions, equivalent to traditional CBT. Regular face-to-face sessions allow the therapist to start therapy in full contact with the child and the parents in order to build therapeutic alliance and establish treatment principles. However, as soon as the child starts with ERP exercises at home (week 2), an additional videoconferencing meeting is scheduled, resulting in two appointments with the therapist per week. During the videoconferencing sessions, the therapist guides the child while carrying out an ERP exercise at home or at another location if applicable. In this way, the therapist can provide extra support to the child when performing ERP exercises and solve problems directly. In the second part of the treatment, from week 6 onwards, the frequency of the face-to-face sessions is reduced from weekly to once in 2 weeks, since the treatment principles are expected to be established by this time and the main focus becomes continuation of ERP exercises. From this point, two videoconferencing sessions (guided ERP at home) and one face-to-face session are scheduled in a 2-week period. This schedule offers more frequent therapist contact than the usual weekly sessions in traditional CBT and provides the therapist with extra tools to ensure adequate execution of ERP exercises in a natural environment.

In the first face-to-face session (week 1), the therapist provides psychoeducation about OCD and treatment (CBT), augmented

with the psychoeducation tool in the app. The eCBT concept is introduced, including an explanation of the app system. The therapist starts with an OCD symptom inventory, which will be completed during the coming weeks. The child as well as parents identify the three most important OCD-related problems (*top problems* measure). In the coming week, the child and/or parents report OCD symptoms in the app. They also start with ratings via the app. The therapist discusses the outcomes of the ratings during the face-to-face sessions. In the next session (week 2), the therapist and child establish a symptom hierarchy, and ERP exercises are set up. The first ERP exercise is practiced together in the session and will be further practiced at home. An appointment is made for a videoconferencing session later that week to guide the ERP exercise at home. In the third face-to-face session (week 3), the therapist evaluates the ratings (app) with the family and discusses the first experiences with practicing ERP at home. A new ERP exercise is selected (or the previous ERP exercise is adapted) to be practiced during the coming week. The new ERP exercise is first practiced during the session and will be further practiced at home. Based on clinical considerations, the therapist may introduce cognitive interventions (eg, challenging dysfunctional thoughts) during this session. Cognitive interventions are not mandatory but can be used to support the ERP exercises and increase motivation. The manual provides for different cognitive interventions, including guidelines for when to apply these interventions, allowing the therapist to customize the treatment to the child's needs, capacities, and preferences. The face-to-face session will be followed by a videoconferencing session (guided ERP at home) later that week. From this point, the face-to-face sessions have the same structure and include evaluating the ratings and the ERP exercises practiced at home, preparing new ERP exercises, practicing ERP exercises in the session, and introducing optional cognitive interventions. From week 4, the child works on a personal support plan, which is supported by the "toolbox" feature in the app. The "toolbox" will be continuously supplemented and refined during the treatment. At the end of the treatment (weeks 12-14), an individualized relapse prevention plan is added to the toolbox. Multimedia Appendix 4 provides an overview of the treatment.

Research Protocol

The research protocol (version March 2020) describes an open study to explore the acceptability, feasibility, and effectiveness of eCBT for pediatric OCD.

Aims and Hypotheses

The aim of the study is to explore whether eCBT is (1) a feasible intervention in terms of treatment drop out; (2) an acceptable intervention; and (3) an effective intervention for children and adolescents with OCD in terms of positive treatment outcomes and showing noninferiority to traditional CBT (Nordic Long-term OCD Treatment Study [NordLOTS]) [11] for the primary outcome measure (Children's Yale-Brown Obsessive-Compulsive Scale [CY-BOCS]).

We hypothesize that (1) preterm treatment drop out will be equivalent or lower than that found for traditional CBT (≤10%) [11]; (2) eCBT will be positively evaluated by children and their parents; (3) there will be a considerable reduction in OCD symptoms after treatment; and (4) the treatment outcome (CY-BOCS) for eCBT will show noninferiority to traditional CBT (NordLOTS) [11].

Methods

Study Design and Sample Size

This study is an open trial using a historical control design to explore the feasibility, acceptability, and effectiveness of eCBT in children and adolescents with OCD. To examine noninferiority of eCBT to traditional CBT, the treatment outcome for eCBT (CY-BOCS) will be compared to data collected in the NordLOTS [11]. The intended sample size is 30 participants.

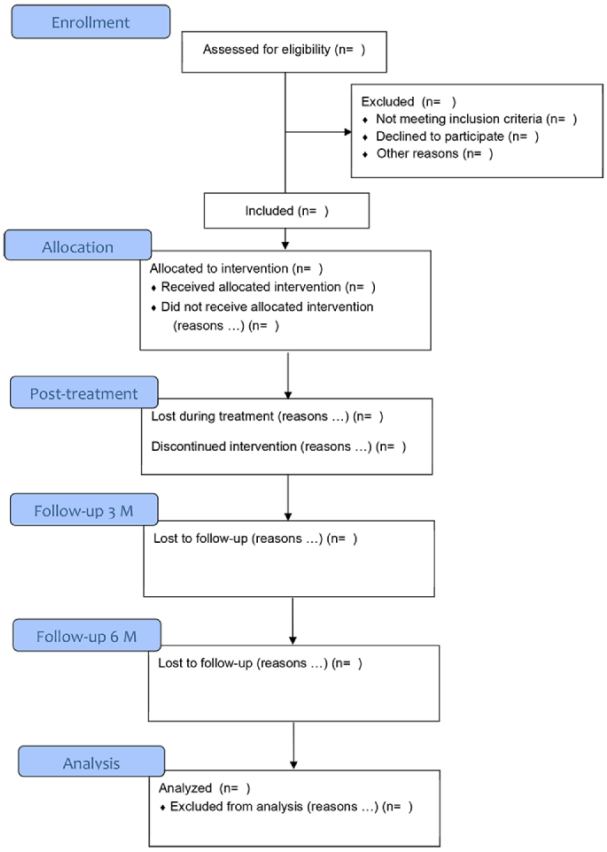
Study Setting and Recruitment

Children who visit the outpatient clinic of the Department of Child and Adolescent Psychiatry at St. Olavs University Hospital (Trondheim) or at BUP Klinikk (Aalesund), and meet the study's eligibility criteria are informed about the study and asked to consider participation. They receive the opportunity to ask questions and have a reasonable amount of time for consideration. Consenting patients are enrolled in the study. During the intake procedure, a qualified professional confirms OCD diagnosis and comorbid disorders using a semistructured interview (Schedule for Affective Disorders and Schizophrenia for School-Age Children Present and Lifetime Version [K-SADS-PL]) [34] if not completed prior to the trial. A standardized questionnaire is used to collect information about demographics and symptom/treatment history.

Study Procedures

All participants receive eCBT. For participants not having a smartphone and for those using an iPhone, an Android smartphone will be lent for the purpose of the study. Concurrent medication is allowed and will be reported during the study. Ongoing psychological treatment for OCD other than eCBT is not allowed. Participants can leave the study at any time for any reason if they wish to do so without any consequences. The investigator can decide to withdraw a participant from the study for urgent medical reasons. The following stop rules for study participation are applied: (1) problems other than OCD requiring acute other treatment (eg, severe depression and suicidal ideation) and (2) severe increase in OCD symptoms and insufficient response to eCBT treatment. Figure 3 shows the flow diagram of the study.

Figure 3. Flow diagram.



Participants

To be eligible for study participation, a participant must meet all of the following criteria: (1) age 7-17 years (inclusive); (2) primary Diagnostic and Statistical Manual of Mental Disorders (DSM)-5 diagnosis of OCD; and (3) CY-BOCS score ≥16.

A potential participant meeting any of the following criteria will be excluded from participation: (1) a psychiatric comorbidity that has a higher treatment priority than OCD and makes participation clinically inappropriate (eg, primary anorexia nervosa, depression with suicidality, and psychosis); (2) mental retardation (if suspected based on the level of functioning, or in the presence of neuropsychiatric comorbidity, an IQ test is performed); and (3) insufficient understanding of the Norwegian language.

Assessments

Assessments are performed pretreatment and posttreatment, and at 3- and 6-month follow-ups. A 12-month follow-up assessment is envisioned.

Outcome Measures

Outcome measures for treatment acceptability, feasibility, and effectiveness are specified below. Table 1 provides an overview of the assessments. Acceptability involves the following: Client Satisfaction Questionnaire-8 (CSQ-8) [35], primary outcome; a treatment evaluation questionnaire for children and their parents composed of the User Experience Questionnaire (UEQ) [36], and qualitative and quantitative treatment-specific questions; a modified version of the Barriers to Treatment Participation Scale (BTPS) [37], child and parent version (for the aim of this study, we shortened the questionnaire, added a child version, and adapted some items to increase the fit to the eCBT treatment package); and a short qualitative interview examining clinicians' treatment satisfaction and their suggestions to improve the treatment. Feasibility involves the following: preterm treatment drop out, primary outcome; and number of eligible participants that rejected/accepted eCBT. Effectiveness involves the following: CY-BOCS [38], primary outcome; Child Obsessive-Compulsive Impact Scale-Revised (COIS-R) [39]; and Family Accommodation Scale for OCD–Self-Rated Version (FAS-SR) [40]. Comorbidity/psychological well-being involves the following: Strengths and Difficulties Questionnaire (SDQ) [41]; Child Behavior Checklist (CBCL) [42]; Youth Self-Report Questionnaire (YSR) [42]; Screen for Child Anxiety-Related Emotional Disorders-Revised (SCARED-R) [43,44]; Mood and Feelings Questionnaire (MFQ) [45]; KINDL-R [46]; Children's Global Assessment Scale (CGAS) [47]; and Clinical Global Impressions Scale-Severity/Improvement (CGI-S, CGI-I) [48].

Other study parameters include the following: study-specific *treatment integrity forms* completed by the therapist following each treatment session and the Trimbos/iMTA Questionnaire for Costs associated with Psychiatric Illness (TiC-P) [49].

Table 1. Overview of assessments.

Assessment	Pretreatment	During treatment	Posttreatment	Follow-up 3 months	Follow-up 6 months
CY-BOCS[a]	IE[b]	N/A[c]	IE	IE	IE
CGI-S[d]	IE	N/A	IE	IE	IE
CGI-I[e]	N/A	N/A	IE	IE	IE
CGAS[f]	Therapist	N/A	Therapist	Therapist	Therapist
COIS-R[g]	Child and parent	N/A	Child and parent	Child and parent	Child and parent
FAS[h]	Parent	N/A	Parent	Parent	Parent
CBCL[i]	Parent	N/A	Parent	N/A	Parent
YSR[j]	Child (≥11 years)	N/A	Child (≥11 years)	N/A	Child (≥11 years)
SCARED[k]	Child and parent	N/A	Child and parent	Child and parent	Child and parent
MFQ[l]	Child and parent	N/A	Child and parent	Child and parent	Child and parent
SDQ[m]	Child and parent	N/A	Child and parent	Child and parent	Child and parent
KINDL	Child and parent	N/A	Child and parent	Child and parent	Child and parent
CSQ-8[n]	N/A	N/A	Child and parent	N/A	N/A
Treatment evaluation questionnaire	N/A	N/A	Child and parent	N/A	N/A
BTPS[o] (modified version)	N/A	N/A	Child and parent	N/A	N/A
TiC-P[p]	Parent	N/A	Parent	Parent	Parent
Session integrity form	N/A	Therapist	N/A	N/A	N/A

[a]CY-BOCS: Children's Yale-Brown Obsessive-Compulsive Scale.
[b]IE: independent evaluator.
[c]N/A: not applicable.
[d]CGI-S: Clinical Global Impressions Scale-Severity.
[e]CGI-I: Clinical Global Impressions Scale-Improvement.
[f]CGAS: Children's Global Assessment Scale.
[g]COIS-R: Child Obsessive-Compulsive Impact Scale-Revised.
[h]FAS: Family Accommodation Scale for obsessive-compulsive disorder.
[i]CBCL: Child Behavior Checklist.
[j]YSR: Youth Self-Report Questionnaire.
[k]SCARED: Screen for Child Anxiety-Related Emotional Disorders.
[l]MFQ: Mood and Feelings Questionnaire.
[m]SDQ: Strengths and Difficulties Questionnaire.
[n]CSQ-8: Client Satisfaction Questionnaire-8.
[o]BTPS: Barriers to Treatment Participation Scale.
[p]TiC-P: Trimbos/iMTA Questionnaire for Costs associated with Psychiatric Illness.

Data Management

All hard-copy forms and informed consent forms will be stored in a secured facility. Protection of participant identity will be guaranteed by assigning study-specific unique participant codes. Only the principle investigator (NS) and the executive investigator (LBE) have access to the key for unique study IDs. Codes will be used to conceal identities in all external communications. Rechecks or later use of the data will be possible using the anonymized data file. Later use of the data will only be possible with consent of the participant. Information (raw data) will be stored for 10 years.

Regular reports are sent to the funding agency. The study is not monitored or audited by an independent party.

Safety Procedures

Children and parents are encouraged to report the occurrence of adverse events or undesirable treatment effects to their therapists or to the investigator. Therapists report this information in the treatment integrity forms and contact the research team if needed. In addition, a member of the research team (BW) will discuss the occurrence of adverse events and undesirable treatment effects with the therapists at regular times. The investigator will report all serious adverse events that logically could be expected to be related to study participation or eCBT treatment to the sponsor without undue delay after obtaining knowledge of the events.

In case a participant's condition deteriorates seriously during treatment, the therapist will perform an immediate assessment of the symptoms and will discuss this with the investigator to determine necessary actions.

The additional risk related to study participation for participants is assessed as negligible compared to regular treatment. eCBT follows the treatment principles of CBT, which is the evidence-based treatment for pediatric OCD. In addition, treatment progress and signs of noncompliance are monitored regularly, and immediate steps can be taken when problems are detected. In case of faltering technology (app or webcam), the therapist can be contacted by telephone, email, or face-to-face appointment. Patients can terminate treatment participation at any time and switch to regular treatment if desired. Risks related to technology and security cannot be excluded (ie, hacked data or spyware compromising patient confidentiality). However, security measures are undertaken. Data gathered with the app are stored on a secured server.

Statistical Analysis

Regarding feasibility and acceptability, descriptive statistics will be provided as follows: CSQ-8, treatment evaluation questionnaire, and modified BTPS for treatment acceptability, and preterm treatment drop out and number of eligible participants that rejected/accepted eCBT for treatment feasibility.

Regarding effectiveness, the treatment effect is expressed as percentage symptom improvement based on the CY-BOCS, the percentage of patients with OCD symptoms in the clinical range (CY-BOCS ≥ 16) and in remission (CY-BOCS ≤ 12), and the percentage of treatment responders (≥35% symptom reduction on the CY-BOCS plus CGI-I rating of 1 or 2 "[very] much improved") [50]. Effect size (*d*) is calculated by the mean difference in the CY-BOCS score before and after eCBT divided by the SD of the difference in the score before and after eCBT. We will run a series of linear mixed models with treatment outcome (CY-BOCS, CGAS, COIS-R, FAS-SR, CBCL/YSR, SCARED, and MFQ) as the dependent factor and time as the independent factor. An independent *t* test will be performed to compare the treatment outcome (difference in the CY-BOCS score before and after treatment) in this study with the treatment outcome reported for the NordLOTS [11].

In terms of other study parameters, for treatment adherence, treatment integrity forms are evaluated by two raters independently, and Cohen kappa will be calculated. To get an impression of treatment costs, outcomes for the TiC-P (related to the SDQ) will be described.

In case of missing assessments, all possible attempts will be made to contact participants.

For feasibility and acceptability analyses, missing data will be described. Acceptability analyses will be conducted on cases having complete data on these measures after treatment.

Regarding treatment outcome, an algorithm for handling missing data is integrated in linear mixed model analyses. Cases with missing data at baseline will be excluded from analyses.

Sample Size

As the intervention concerns an innovative treatment, the study is primarily aimed at studying acceptability and feasibility. For this goal, a power calculation cannot be performed.

To explore noninferiority of eCBT to traditional CBT (as delivered in the NordLOTS), we will use a historical control design. A power calculation (noninferiority margin set at 4 points on the CY-BOCS) shows that 21 participants per treatment arm would be sufficient to show noninferiority (80% power).

Results

The study has been approved by the Regionale komiteer for medisinsk og helsefaglig forskningsetikk (REK 2016/716/REK nord) and has been registered in the ISRCTN registry (ID: ISRCTN37530113). The study will be conducted according to the principles of the Declaration of Helsinki (version October 19, 2013; WMA, 2013) [51] and in accordance with the Medical Research Involving Human Subjects Act (WMO) and Good Clinical Practice (GCP) standards.

Multimedia Appendix 5 provides a summary of the trial registration data. Informed consent will be obtained prior to enrollment in the study. Inclusion started on September 04, 2017. Data collection is ongoing. The results will be published in peer-reviewed academic journals, presented at scientific conferences, and communicated to the participants and patient organizations. International Committee of Medical Journal Editors (ICMJE) criteria on contributorship and authorship are applied.

Discussion

This study is the first step in testing the acceptability, feasibility, and preliminary effectiveness of eCBT. In case of positive results, future steps include improving the eCBT treatment package based on feedback from service users, examining cost-effectiveness in a randomized controlled trial, and making the package available to clinicians and other service providers treating OCD in children and adolescents.

Although eCBT has not been developed with the intention to overcome all barriers to treatment, we aim to improve treatment response by offering a more focused application of CBT

principles in a user-friendly way. A future step would be to examine which approach works best for which patients.

Acknowledgments

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Conflicts of Interest

None declared. For the sake of completeness, LHW reports personal fees from Bohn Stafleu van Loghum, Houten, the Netherlands (publisher), outside the submitted work, and BW reports personal fees from Gyldendal Akademisk forlag, Olso, Norway (publisher), outside the submitted work.

Multimedia Appendix 1

Overview of the app system.
[PDF File (Adobe PDF File), 59 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Psychoeducation tool: stories.
[PDF File (Adobe PDF File), 60 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Questions for monitoring treatment progress via the app system.
[PDF File (Adobe PDF File), 74 KB-Multimedia Appendix 3]

Multimedia Appendix 4

Enhanced cognitive behavioral therapy: treatment overview.
[PDF File (Adobe PDF File), 99 KB-Multimedia Appendix 4]

Multimedia Appendix 5

Summary of trial registration data.
[PDF File (Adobe PDF File), 98 KB-Multimedia Appendix 5]

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Abbreviations

BTPS: Barriers to Treatment Participation Scale
CBCL: Child Behavior Checklist
CBT: cognitive behavioral therapy
CGAS: Children's Global Assessment Scale
CGI-I: Clinical Global Impressions Scale-Improvement
CGI-S: Clinical Global Impressions Scale-Severity
COIS-R: Child Obsessive-Compulsive Impact Scale-Revised
CSQ-8: Client Satisfaction Questionnaire-8
CY-BOCS: Children's Yale-Brown Obsessive-Compulsive Scale
eCBT: enhanced cognitive behavioral therapy
ERP: exposure with response prevention
FAS-SR: Family Accommodation Scale for OCD–Self-Rated Version
K-SADS-PL: Schedule for Affective Disorders and Schizophrenia for School-Age Children Present and Lifetime Version
MFQ: Mood and Feelings Questionnaire
OCD: obsessive-compulsive disorder
SCARED-R: Screen for Child Anxiety-Related Emotional Disorders-Revised
SDQ: Strengths and Difficulties Questionnaire
tCBT: technology-based cognitive behavioral therapy
TiC-P: Trimbos/iMTA Questionnaire for Costs associated with Psychiatric Illness
UEQ: User Experience Questionnaire
YSR: Youth Self-Report Questionnaire

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RESEARCH ARTICLE

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Acceptability and feasibility of enhanced cognitive behavioral therapy (eCBT) for children and adolescents with obsessive–compulsive disorder

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Abstract

Introduction: Obsessive–compulsive disorder (OCD) is a disabling mental health disorder affecting 1–3% of children and adolescents. Cognitive behavioral therapy (CBT) is recommended as the first-line treatment, but is limited by accessibility, availability, and, in some cases, response to treatment. Enhancement with Internet technologies may mitigate these challenges.

Methods: We developed an enhanced CBT (eCBT) treatment package for children and adolescents with OCD to improve treatment effect as well as user-friendliness. This study aims to explore the feasibility, acceptability, and preliminary effectiveness of the eCBT intervention. The eCBT protocol consists of 10 face-to-face and 12 webcam sessions delivered in 14 weeks. CBT is enhanced by a smartphone application (app) for children and parents to support and monitor treatment, psychoeducative videos, and therapist-guided webcam exposure exercises conducted at home. Assessments were performed at baseline, post-treatment, and at 3- and 6-month follow-up. Primary measures of outcomes were the the Client Satisfaction Questionnaire-8 (CSQ-8) (acceptability), treatment drop-out (feasibility) and the Children's Yale-Brown Obsessive–Compulsive Scale (CY-BOCS) (preliminary effectiveness).

Results: This paper describes 25 patients with OCD (aged 8–17 years) treated with eCBT. Results indicated that children and parents were satisfied with eCBT, with CSQ-8 mean scores of 27.58 (SD 0.67) and 29.5 (SD 3.74), respectively (range 8–32). No patients dropped out from treatment. We found a mean of 63.8% symptom reduction on the CY-BOCS from baseline to post-treatment. CY-BOCS scores further decreased during 3-month and 6-month follow-up.

Conclusion: In this explorative study, eCBT for pediatric OCD was a feasible, acceptable intervention demonstrating positive treatment outcomes.

Keywords: Obsessive–compulsive disorder (OCD), Cognitive behavioral therapy (CBT), Enhanced cognitive behavioral therapy (eCBT), Children, Adolescents

Introduction

Obsessive–compulsive disorder (OCD) is a disabling mental health disorder affecting 1–3% of children and adolescents [1, 2], leading to significant impairment [3] and reduced quality of life [4]. Without treatment, OCD has a chronic course in 40–60% of cases [5, 6]. Cognitive

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behavioral therapy (CBT) is the first line of treatment for children with OCD [7–9]. However, from a global perspective, not all patients who need CBT receive it, due to its limited availability (i.e., lack of experienced therapists, geographic barriers, high costs) [10–12].

The use of Internet technology may address some of these challenges. Several researchers have attempted to improve the availability and accessibility of CBT by developing low-cost and easily accessible OCD self-help treatment programs [13–16]. In addition, smartphone applications (apps) have been used to overcome geographic barriers and to improve compliance with Exposure and Response Prevention (ERP) [15, 17]. A recent systematic review concluded that Internet-based CBT (iCBT) programs for pediatric OCD are feasible, acceptable, and possibly effective. However, the systematic review was based on six studies (N = 96), and the authors called for more studies on iCBT for pediatric OCD before reaching firmer conclusions [18].

Exposure and Response Prevention can be affected by low motivation, avoidance behavior, and the lack of possibilities to carry out therapist-guided exposure exercises in the patient's home. Children often do their homework best in the first days after a treatment session, but efforts then decrease gradually. In a study of internet delivered CBT with minimal therapist contact by Lenhard et al., [15] half of the sample were satisfied with the internet format most of the time but would have liked to meet with a clinician occasionally. Combining traditional face-to-face sessions with webcam sessions at home and an app is one possible way to address these problems, to increase treatment intensity, and to make use of children's and adolescents' fascination with internet technology.

In order to address the challenges with traditional CBT highlighted above, we developed an enhanced cognitive behavior therapy (eCBT) treatment package for children and adolescents with OCD. The main goal of this package is to improve treatment satisfaction and compliance, to intensify exposure and response prevention, and thereby improve treatment outcomes. This study reports on the first 25 patients to receive eCBT and explores acceptability and feasibility and initial treatment outcomes. Our hypotheses are that eCBT for children and adolescents with OCD will be acceptable for both patients and their parents, and feasible for users as well as treatment providers. In addition, we hypothesize that eCBT will have positive outcomes in a preliminary evaluation.

Methods

Design

This case series study evaluated outcomes for 25 patients treated with eCBT for OCD over a 25-month period (from January 2018 to February 2020). Assessments were performed pre- and post-treatment, and at 3- and 6-month follow-up. Efficacy measures were completed at all assessment points. Treatment acceptability was examined at the post-treatment assessment.

Intervention

Enhanced CBT (eCBT) is an innovative treatment package for children and adolescents with OCD. It integrates modern technology with well validated principles of CBT. eCBT was developed by academic experts in the treatment of OCD, experts in IT, and media developers. Advice from service users who had received traditional CBT and clinicians about what could help them to structure and improve treatment was incorporated in the final version of eCBT. eCBT employs evidence-based principles of CBT taken specifically from Norwegian [19] and Dutch [20] treatment manuals for pediatric OCD. Similar to traditional CBT, eCBT contains psychoeducation, Exposure and Response Prevention (ERP), cognitive interventions, and relapse prevention strategies. In addition to traditional face-to-face treatment sessions, eCBT enhances treatment by offering sessions in situ (e.g., in the child's home) via webcam, allowing more frequent therapist contact and the ability to conduct more ecologically valid exposure exercises. Parents are also actively involved in the treatment.

eCBT covers a 14-week treatment period. The first part of the treatment (weeks 1–5) consists of weekly (45-min) face-to-face sessions, equivalent to traditional CBT. At least one of the four psychoeducation videos was demonstrated by the therapist during the first sessions and patients and families are encouraged to watch all of them at home. All videos were available on the app to watch them at any time. As soon as the child starts with ERP exercises at home (week 2), treatment is supplemented by a weekly (15-min) videoconferencing meeting, resulting in two appointments with the therapist per week. Simultaneously children will start logging their ERP homework in the app.

During the webcam sessions, the therapist guides the child while carrying out an ERP exercise at home or at another location, if applicable. In the second part of the treatment, from week 6 onwards, the frequency of the face-to-face sessions is reduced from weekly to bi-weekly, while the frequency of webcam sessions (guided ERP at home) is increased, resulting in one face-to-face session and two videoconferencing meetings in a two-week period. This schedule provides the therapist with extra tools to ensure adequate execution of the ERP exercises in a natural environment. However, total therapist time for eCBT is equivalent to traditional CBT. The default frequency of sessions could be altered and personalized to patients' needs but could not exceed the total number

of sessions (a maximum of 10 face-to-face sessions and up to 12 shorter webcam sessions).

The eCBT package is fully integrated into the treatment process and consists of a smartphone app for children, a smartphone app for parents, and a web-based computer application for therapists. Each platform is interconnected. The main goals of the eCBT package are to increase treatment adherence, provide more ecologically valid exposure exercises, and encourage parents' involvement in the treatment process. The eCBT package further contributes to personalizing treatment to individual needs. The app provides information about OCD and CBT (i.e., psychoeducation videos showing animated narratives of children with OCD), supports and structures ERP exercises at home, and closely monitors treatment progress (short and frequent assessments with direct feedback to the patient and therapist). The web-based platform for therapists serves a coordinating and monitoring function. The app can be used in the treatment sessions together with the therapist or independently at home. It was developed for the Android system only, and children who had an iPhone had to borrow an Android phone from the study.

Participants

Participants were eligible if they met the following criteria: age 7–17 years; primary DSM-5 diagnosis of OCD; and Children's Yale-Brown Obsessive–Compulsive Scale (CY-BOCS) score ≥ 16. Exclusion criteria were psychiatric comorbidity which had a higher treatment priority than OCD and made participation clinically inappropriate (e.g., primary anorexia nervosa, depression with suicidality, or psychosis); ongoing psychological treatment for OCD other than eCBT; significant developmental delays; or insufficient understanding of the Norwegian language. Concurrent medications were allowed during the study.

Measures

Acceptability measures

The Client Satisfaction Questionnaire 8 (CSQ-8) examines client satisfaction with (mental) health services. The questionnaire consists of eight items that are answered on a 4-point Likert scale. The total score ranges from 8 to 32, with higher scores indicating more satisfaction [21, 22].

The User Experience Questionnaire (UEQ) measures users' experiences with interactive products. The UEQ contains six scales (attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty) and has 26 items. Each item presents two opposites from one dimension (for example, not understandable (1) to understandable (7)) [23].

The Treatment Evaluation Questionnaire (TEQ) was developed for this study to assess the experiences of children and parents with eCBT. The TEQ consisted of 10 and 11 items (parent and child version respectively) that were answered on a 5-point Likert scale (from very helpful to not helpful at all). In addition, participants were encouraged to share suggestions and comments.

Feasibility measures

Treatment drop-out was the primary measurement of feasibility and was defined as premature cessation of treatment before completing the planned number of sessions according to the protocol and not due to patients' recovery. A session integrity form was developed to monitor eCBT treatment sessions and to record deviations from the eCBT treatment manual. The session integrity form was completed by the therapist after each session. Session integrity forms were inspected for deviations by two of the authors (LBE and BW).

The modified Barriers to Treatment Participation Scale (BTPS) is a self-reporting questionnaire to measure perceived barriers to participation in treatment. Barriers include practical obstacles related to participation, perceptions that treatment is (too) demanding, not helpful, or of little relevance to the child's problems, and a poor alliance with the therapist [24]. For this study, the BTPS was modified, and items not applicable for Norwegian clinical services and this study were omitted. The modified BTPS consisted of 27 items for the parents' version. For the children's version, 15 items from the parents' version, applicable to children's situation were reworded. All items were answered on a 5-point Likert scale (1 = never a problem to 5 = very often a problem).

Efficacy measures

The Children's Yale-Brown Obsessive–Compulsive Scale (CY-BOCS) is a clinician-rated, semi-structured interview used to assess the severity of OCD symptoms. The CY-BOCS interview consists of 10 items measuring five dimensions (time occupied by symptoms, interference, distress, resistance, and degree of control over symptoms) of obsessions and compulsions. The CY-BOCS total score ranges from 0 to 40 (clinical cut-off = 16). CY-BOCS shows reasonable reliability and validity [25] [26].

The Clinical Global Impression (CGI) measures symptom severity, treatment response, and efficacy in treatment studies. It scales for severity and improvement. The Severity Scale (CGI-S) is a 7-point scale from 1 (normal) to 7 (among the most extremely ill patients). The Improvement Scale (CGI-I) is also a 7-point scale from 1 (very much improved) to 7 (very much worse) [27]. The CGI is included in the CY-BOCS.

Other measures

The Schedule for Affective Disorders and Schizophrenia for School-Age Children –Present and Lifetime Version (K-SADS-PL) is a semi-structured diagnostic interview that assesses child and adolescent psychopathology according to DSM-IV criteria [28]. The K-SADS-PL was used to confirm inclusion criteria, i.e., a diagnosis of OCD and to assess comorbidities, that could influence treatment priorities. Symptoms can be classified as "not present", "possible", "in remissions" or "certain". In this study OCD and other diagnosis were given based on "certain" symptoms only.

Demographic information, symptom development and treatment history were collected systematically from parents with a standardized questionnaire.

Procedures

Patients were referred to the Department of Child and Adolescent Psychiatry, St. Olav's University Hospital, Trondheim. Patients meeting the study's eligibility criteria were informed about the eCBT study. They had a reasonable amount of time to consider participation and to ask questions. After informed consent was obtained, patients were enrolled into the study. During treatment, all patients were offered Android Mobile Phone with preinstalled eCBT for free. However, patients were allowed to use their own Android Phone, if they preferred, as eCBT was produced for Android system.

At the start of eCBT, participants received technical assistance with app activation and videoconferencing software. If they encountered technical problems during treatment, they were advised to contact the project team. Assessments were carried out at baseline, after completion of eCBT treatment, and at 3 and 6 months after treatment. The CBT therapists involved were either licensed clinical psychologists (n = 6) or child and adolescent psychiatrists (n = 2). All were trained in CBT with ERP and had weekly supervision by one of the co-authors (BW).

A qualified mental health professional assessed obsessive–compulsive and other psychiatric symptoms, using the K-SADS-PL prior to referral to the OCD team. An independent evaluator—a psychologist not involved in the treatment of any participant—conducted and scored the CY-BOCS interviews. However, in some few cases when he was not available, another therapist not informed about the treatment of the participant carried out this assessment.

Descriptive statistics

For treatment acceptability the Client Satisfaction Questionnaire 8 (CSQ-8) group mean scores and standard deviations for each item were calculated for children and parents separately. For the User Experience Questionnaire (UEQ), we calculated group means and standard deviation for all six subscales for children as well as parents. The Treatment Evaluation Questionnaire (TEQ) was analyzed tallying each participant's (children and parents) rating for each item.

Treatment feasibility was examined by tallying treatment dropouts. For the modified Barriers to Treatment Participation Scale (BTPS) the frequency of perceived barriers to treatment is descriptively summarized.

Treatment outcomes for OCD are assessed by calculating percentage improvement from baseline to post-treatment on the CY-BOCS. The criterion for treatment response was $\geq 30\%$ symptom reduction, and the criterion for clinical remission was a CY-BOCS score ≤ 10 [29–32]. Longitudinal outcomes on the CY-BOCS were assessed at baseline, post-treatment, and at 3- and 6-month follow-up, and are presented in group mean scores and standard deviations at the respective assessment points. SPSS software, version 25, was used [33].

Ethics

The study was approved by the Regional Committee for Medical and Health Research Ethics (No2016/716/REK Nord) and registered with the ISRCTN (https://www.isrctn.com/) registry (trial ID: ISRCTN37530113) [34]. The study procedures were in accordance with the principles of the Declaration of Helsinki [34] and Good Clinical Practice (GCP) standards [35].

Results

Between January 2018 and February 2020, 45 eligible patients at the Departments of Child and Adolescent Psychiatry, St. Olav's University Hospital, Trondheim, and Aalesund Hospital were informed about the present study. Twenty-six patients accepted eCBT, 11 preferred a brief intensive CBT group treatment, and 8 patients refused any treatment for OCD. The first included patient did not have webcam sessions due to initial technical problems and was therefore excluded. All 25 patients enrolled in the eCBT treatment program completed the treatment.

Fourteen patients had comorbid disorders (as confirmed with the K-SADS) including tic disorder, anxiety disorder, attention deficit hyperactivity disorder (ADHD), eating disorder, and autism spectrum disorder. Table 1 provides more details about patients' socio-demographic and clinical characteristics.

Acceptability

The Client Satisfaction Questionnaire 8 (CSQ-8) was filled in by 22 children and 18 parents. CSQ-total scores ranged from 23 to 32 (M = 27.7, SD = 3.9) for

Table 1 Clinical characteristics and assessments at baseline, post-treatment, and at 3- and 6-month follow-up (n = 25)

Age (years)	Gender	Comorbidities (K-SADS)	Medication (dose/day)	Number of sessions: face-to-face/webcam	CY-BOCS total score				CGI–Severity / CGI-Improvement			
					Pre	*Post*	*3 m*	*6 m*	*Pre*	*Post*	*3 m*	*6 m*
12	M	SAD, GAD, ADHD, Tic disorder, ASD	Guanfacine (4 mg)	14/1	34	17	0	0	6	3/2	1/1	1/1
17	F	None	None	9/6	25	6	0	0	5	1/1	1/1	1/1
9	M	Depression, Eating disorder	None	7/1	18	11	11	21	4	1/2	1/3	5/3
16	F	None	None	10/11	18	14	18	N.A	4	4/3	5/3	N.A
10	F	SAD, Spec. phobia, ADHD, Tic disorder	None	6/1	25	0	0	0	5	1/1	1/1	1/1
10	F	GAD	None	6/3	24	0	0	0	4	1/1	1/1	1/1
17	M	Tic disorder	None	10/2	35	22	20	18	6	4/3	2/4	1/4
15	F	None	None	10/2	24	2	2	2	5	1/1	1/1	1/1
13	M	Tic disorder	None	10/6	31	8	0	0	5	4/1	1/1	1/1
12	F	Eating disorder	Risperidone (1 mg)	14/1	34	33	N.A	5	6	6/3	N.A	1/1
13	F	GAD	None	10/7	31	23	N.A	N.A	6	5/3	N.A	N.A
13	F	None	Methylphenidate (40 mg)	9/4	20	5	2	1	4	1/1	1/1	1/6
14	F	None	None	12/9	27	7	4	19	5	1/1	2/1	4/3
17	M	ASD	None	3/2	21	0	N.A	N.A	5	1/1	N.A	N.A
8	F	None	None	7/5	25	0	0	0	4	1/1	1/1	1/1
13	M	None	None	10/6	30	0	0	0	4	1/1	1/1	1/1
16	M	N.A	None	7/7	25	20	N.A	N.A	5	4/3	N.A	N.A
13	F	ASD	None	10/3	29	12	1	0	6	3/1	1/2	1/1
13	F	None	None	9/4	18	12	12	12	4	3/3	3/3	2/3
8	M	None	None	8/3	31	0	0	0	5	1/1	1/1	1/1
14	M	Bipolar disorder	Aripiprazole (20 mg)	4/6	21	17	N.A	N.A	4	3/3	N.A	N.A
17	F	None	None	8/9	32	0	0	0	5	1/1	1/1	1/1
8	M	PTSD	None	7/5	20	10	2	0	4	1/2	1/1	1/1
16	F	Spec. phobia, ADHD	Methylphenidate (20 mg)	11/4	21	14	6	3	5	2/1	2/1	1/1
14	M	ASD, Tic disorder	None	9/4	25	0	0	0	3	1/1	1/1	1/1

K-SADS Kiddie Schedule for Affective Disorders and Schizophrenia, *CGI* Clinical Global Impression scale, *CY-BOCS* Children's Yale-Brown Obsessive–Compulsive Scale, *GAD* Generalized Anxiety Disorder, *SAD* Separation Anxiety Disorder, *ADHD* Attention Deficit Hyperactivity Disorder, *ASD* Autism Spectrum Disorder, *PTSD* Post Traumatic Disorder, *N.A.* Not available, *M* male, *F* female

children, and from 24 to 32 (M = 29.5, SD = 3.7) for parents (Table 2). Participants scored all items 3 "mostly satisfied" or 4 "highly satisfied". There was no statistically significant difference between CSQ-8 scale scores for parents and children.

The User Experience Questionnaire (UEQ) was filled in by 22 children and 19 parents. All subscales were rated as 'average' by both children and parents (Fig. 1).

The Treatment Evaluation Questionnaire (TEQ) was completed by 24 children and 23 parents (Fig. 2). One of the parents had only filled in 2 items. Most positively evaluated were the face-to-face sessions, reported as being helpful or very helpful by 20 children (83%) and 19 parents (82%). Fifteen children (62,5%) and 19 parents (82%) found psychoeducation videos helpful or very helpful. Fourteen children (58%) and 14 parents (61%) found webcam sessions helpful or very helpful. Most negatively evaluated were the daily and weekly evaluation questions, rated as not helpful by 6 children (25%) and 3 parents (13%). Similarly, 6 children and 3 parents rated overall usefulness of the app as unhelpful. Reminders on the app was rated as unhelpful by four children and 3 parents (Fig. 2).

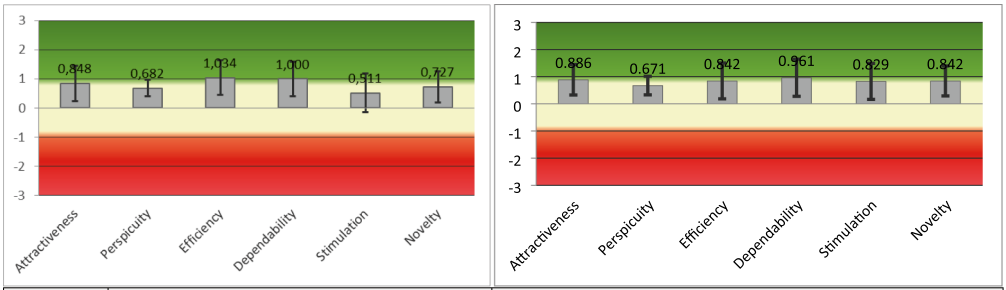
Table 2 Client Satisfaction Questionnaire (CSQ-8): Children's and parents' rating

Item	Children (n = 22); mean (SD)	Parents (n = 18); mean (SD)
1. Quality of service	3.41 (0.59)	3.67 (0.49)
2. Kind of service wanted	3.50 (0.60)	3.61 (0.50)
3. Needs met	3.30 (0.76)	3.56 (0.51)
4. Would recommend to friend	3.65 (0.57)	3.78 (0.43)
5. Satisfaction with help received	3.32 (0.84)	3.67 (0.49)
6. Dealt with problems	3.52 (0.60)	3.72 (0.46)
7. Overall satisfaction	3.48 (0.67)	3.83 (0.38)
8. Would return to program	3.40 (0.67)	3.67 (0.49)
Total score (range 8–32)	27.58 (0.67)	29.5 (3.74)

Feasibility

No participants dropped out because of premature cessation. No participants dropped out because of premature cessation.No major deviations from the content of the eCBT treatment manual were reported. However, at the start of the eCBT program, several webcam sessions were cancelled by participants or ended in a phone call session due to initial hesitation on the part of patients or parents to use webcams, or technical problems on either the therapist or patient side. Unstable Internet connection was the most common technical problem reported in session integrity forms. Examples of other reasons were: one patient cancelled three scheduled webcam sessions because he had not downloaded the webcam application. Another came to see the therapist at the clinic in two instances when webcam sessions were scheduled. For two patients it was difficult to keep up webcam sessions (due to comorbid problems, i.e., ASD and eating disorder), resulting in only one completed session. This was compensated for by four face-to-face sessions in both cases.

Results for the modified Barriers to Treatment Participation Scale (BTPS) showed that, parents listed 8 barriers



Subscale	Children (n=22, missing 3); mean (SD)	Parents (n=19, missing 6); mean (SD)
Attractiveness	0.85 (1.46)	0.88 (1.24)
Perspicuity	0.68 (0.66)	0.67 (0.76)
Efficiency	1.03 (1.43)	0.84 (1.46)
Dependability	1.00 (1.43)	0.96 (1.51)
Stimulation	0.51 (1.57)	0.83 (1.47)
Novelty	0.73 (1.28)	0.84 (1.22)

Fig. 1 User Experience Questionnaire (UEQ): Children's and Parents' rating

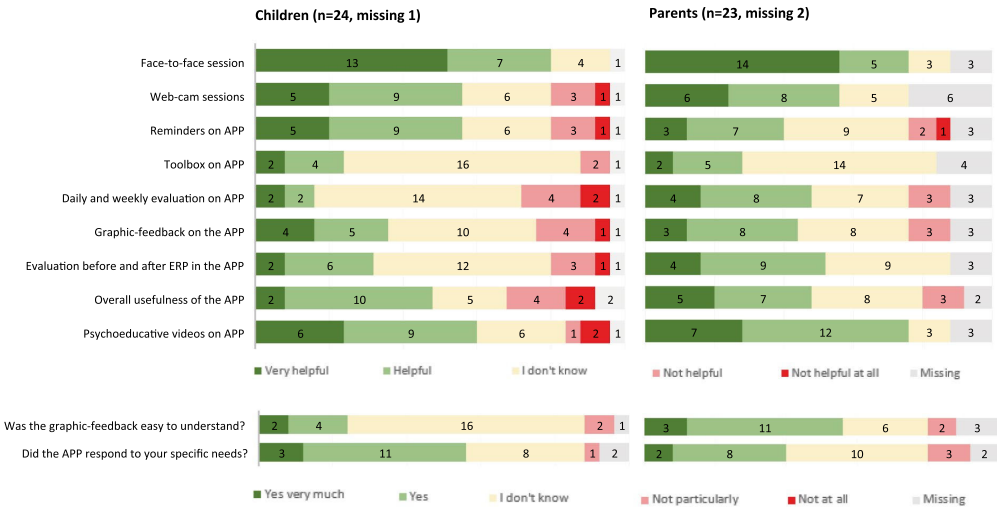


Fig. 2 Treatment Evaluation Questionnaire

and children listed 5 barriers to treatment as "often a problem" (see Fig. 3). The most frequent rated barrier to treatment was work related issues, endorsed by four parents. Two children endorsed, that the therapist did not support them enough.

Treatment outcomes

Table 1 presents CY-BOCS, CGI-S and CGI-I measures at baseline, post-treatment, and at 3- and 6-month follow-up. There was a 63.8% mean symptom reduction on the CY-BOCS from baseline to post-treatment. At post-treatment evaluation, 19 patients scored below the clinical cut-off (CY-BOCS total score ≤ 15), and 15 patients met the criterion for clinical remission (CY-BOCS ≤ 10). Of the six patients with CY-BOCS scores above 15, three met the criterion for treatment response, showing at least 30% reduction of OCD severity. Of the 19 responders, 17 maintained their treatment gains with CY-BOCS scores further improving during 3-month and 6-month follow-ups.

Discussion

This study explored feasibility, acceptability, and treatment outcomes of a newly developed enhanced cognitive behavioral therapy (eCBT) program for children and adolescents with OCD.

No patients dropped out of the eCBT study, suggesting that eCBT was a feasible treatment for children and parents. Interestingly, both parents and children reported very few barriers to treatment, and those reported were individually distributed single items. Only work-related issues were reported as "often a problem" by four parents (Fig. 3). Patient's reluctance to do assigned homework was a common rated barrier to treatment. However, this is a well-known issue immanent to exposure therapy. The finding that nine children reported that they were not improved and need longer treatment might be explained by the three non-responders, the partial symptom reduction in three others, or by a temporary problem during difficult treatment phases.

Some technical issues were reported by both patients and therapists in the initial phase of the program, though these were relatively easily addressed (e.g., poor Internet connection). One patient's OCD symptoms interfered with using the app. Initially they could not touch a cell phone due to fear of contamination, but after addressing this fear with the therapist they were able to engage in a full course of eCBT.

Overall, a smooth implementation of the program may have been facilitated because eCBT employs traditional CBT principles, which were well known to therapists. In addition, all therapists received a weekly supervision and assistance with technical problems from the eCBT project team. Moreover, the eCBT team expended a lot of effort in the developmental phase (i.e., consulting service users, exploring best possible technical solutions with IT experts) to make eCBT a user-friendly treatment for both patients and therapists. Finally, parents and children

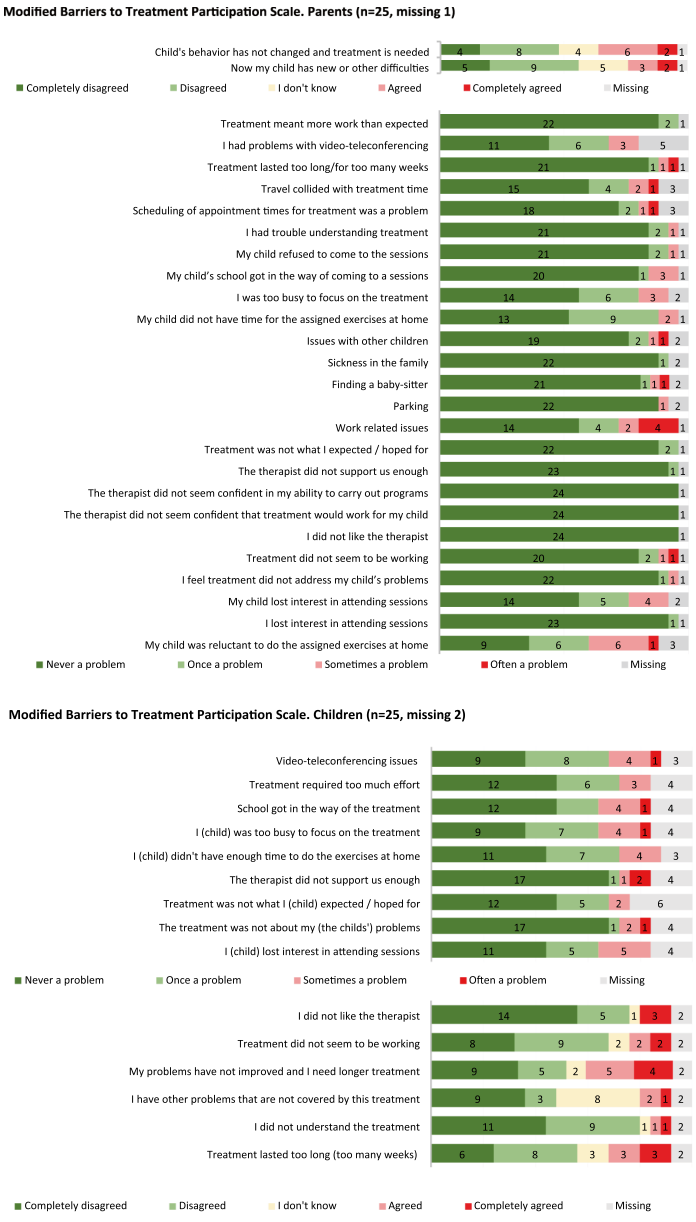


Fig. 3 Modified Barriers to Treatment Participation Scale. Parents (n = 25, missing 1)

reported no major barriers that could preclude smooth implementation of eCBT.

To obtain detailed user feedback on acceptability, three questionnaires were used. The CSQ-8 tracks client satisfaction with the full eCBT package, while the TEQ evaluates the different parts of the package, and the UEQ reflects user experience with interactive products, specifically with the app. Overall, participants reported that they were highly satisfied with eCBT, which is reflected by high CSQ-8 mean total scores for both children and parents.

Evaluation of user experience overall demonstrated a neutral evaluation of all subscales of both parents and children (Fig. 1). High ranking of general satisfaction with eCBT package on the CSQ and the lower ranking of the user experience maybe because the hard exposure work was exclusively associated with the app. In addition, it is not surprising that children gave lower scores for app on UEQ novelty and attractiveness subscales. Children compared eCBT app to games, social media and other interactive apps, which are created for entertainment purpose and are usually more "fun" and more attractive for children.

In the evaluation of the different parts of the eCBT package (TEQ, Fig. 2), most children and parents evaluated the face-to-face as well as the videoconferencing sessions positively. One of the features of the app is to help structure and monitor exposure exercises. However, as in traditional CBT, motivation to engage in exposure is crucial. As expected, for the majority of children the app was an inspiring factor, motivating for more exposure, though others were more reluctant when it came to exposure, including use of the app. Regarding specific app features, children and parents were most positive about the psychoeducation videos. While most parents were positive about the assessment questions monitoring treatment progress, the aim of these questions seemed to be less clear for children. In general, parents' evaluations of the app were more positive than children's evaluations. A possible explanation for this might be the different roles of children and parents during treatment. Children may have been less positive about the app because of their experience with the "hard work" that exposure exercises entail, while parents' experience of a gradual reduction of family accommodation and their role as supporters for their child may lead to more positive evaluations.

Overall, users appreciated both the face-to-face and the videoconferencing sessions. Webcam-based videoconferencing sessions offer not only the convenience of treatment at home but also the opportunity to practice therapist-guided ERP easily and realistically in the child's natural environment, where obsessions are most often generated and compulsive behaviors performed. However, face-to-face sessions were rated positively by more participants than the videoconferencing sessions. This might in part reflect the fact that technical problems and a higher amount of uncertainty could have overshadowed the webcam sessions in the initial implementation phase. Our observation was that some children were easier to motivate and worked better in the context of face-to-face sessions, while for others exposure in natural situations at home with a webcam was more effective. Therefore, the opportunity to combine these treatment modalities to provide a more personalized approach, adapting the treatment schedule to individual needs and preferences, might further improve eCBT. This view is supported by a study of a 12-week clinician- and parent-supported Internet-based CBT program with low therapist intensity and with an average clinician time per patient per week of 17.5 min [15]. In this study, 46% of adolescents reported that they were satisfied with the Internet-delivered format, 50% were satisfied with the Internet format most of the time but would have liked to meet with a clinician occasionally, and 4% would have preferred face-to-face treatment.

Although the evaluation of the app was largely positive, the application of some features may need improvement. Participants mainly seemed to use those functions of the app which involved both therapist and patient. Functions like the toolbox, which children could explore and use on their own, were not used and may need to be better explained and integrated into the treatment. The same may apply to assessment questions monitoring treatment in the app. The most vital functions of the app were the OCD symptom inventory and the list for ERP exercises, including monitoring of the accomplishment of exercises. These features allowed a continuous communication between patient and therapist and contributed to improving both session structure and communication.

As is the case with most apps, most users do not utilize all possible functions. To concentrate on the core functions in daily use, with the possibility of applying more sophisticated features when needed, may be a good strategy for future apps [15]. On the other hand, to keep an application simple and straightforward might improve both the attractiveness of the tool and the compliance of users. Reminders for exercises were an ambiguous tool; children with high motivation for treatment did not need reminders, while those with little motivation could experience reminders as annoying.

In general, there was a large improvement in OCD symptoms, with 63.8% mean reduction of CY-BOCS total scores from baseline to post-treatment. Nineteen out of 25 patients had OCD symptoms below the clinical cut-off and 15 of them fulfilled the criterion for remission after eCBT. Three patients responded to

treatment, with a large reduction of CY-BOCS total scores, although at post-treatment their CY-BOCS scores were still above the clinical cut-off. One patient showed no treatment response at all. This patient was first treated at an inpatient unit for anorexia nervosa and subsequently referred for OCD treatment. Her engagement in eCBT was limited: she had little motivation or energy to perform ERP exercises. Later, as her anorexia nervosa symptoms improved, she was able to apply principles learned during eCBT. This patient started exposure exercises on her own and subsequently was deemed to be a responder at 6-month follow-up with a CY-BOCS total score of 5. The two other non-responders had only minor reductions of CY-BOCS scores.

While a direct comparison should not be drawn between large interventional studies and this exploratory study, we noticed similar trends between eCBT and the Nordic long-term OCD treatment study (NordLOTS), as eCBT employs key elements of the NordLOTS manual. In NordLOTS (the largest study to date of the effects of CBT for pediatric OCD), 72.6% of the participants were responders (CY-BOCS total score ≤ 15), and mean reduction on the CY-BOCS was 52.9% (SD 30.9) at post-treatment [31]. Our results are also in line with other studies using Internet technology to deliver CBT. Storch et al. [36], for example, reported a 56.1% reduction of CY-BOCS total score after 14 sessions of webcam-delivered CBT. Farrell et al. [37] reported a 49% CY-BOCS score reduction after 3 face-to-face CBT sessions, followed by maintenance sessions via webcam. Other studies applying various degrees of Internet technology to deliver CBT to children with OCD reported somewhat lower reductions of CY-BOCS scores after treatment [18].

This study has several limitations and should be viewed in its methodological context. The findings are based on a relatively small number of participants, limiting the generalizability of the current findings. Another limitation is the relatively large difference in the distribution of face-to-face versus webcam sessions between patients and the number of therapists (8) who treated 25 patients. This may have contributed to a considerable variability of our data. The app was developed for the Android mobile system only, and children who had an iPhone had to borrow an Android phone from the study. Strengths of this study included the fact that assessments were based on reliable tools and a multi-perspective approach, taking the views of children, parents, and therapists into account, and that CY-BOCS evaluations were performed by an independent rater and not the therapists. In addition, another strength is the follow-up assessment at 6 months. The sample included patients with moderate to severe OCD and high rates of comorbid disorders, which seemed to be representative of the patient population usually seen in our specialized OCD treatment unit.

Conclusions

In this study, eCBT for pediatric OCD was a feasible and acceptable intervention demonstrating positive treatment outcomes. Opportunities to combine face-to-face and webcam treatment modalities as part of a more personalized approach, adapting the treatment schedule to individual needs and preferences, might further improve eCBT.

Abbreviations

ADHD: Attention deficit hyperactivity disorder; ASD: Autism spectrum disorder; BTPS: Barriers to Treatment Participation Scale; CBT: Cognitive behavioral therapy; CGAS: Children's Global Assessment Scale; CGI: Clinical Global Impression Scale; CSQ-8: The Client Satisfaction Questionnaire-8; CY-BOCS: Children's Yale-Brown Obsessive–Compulsive Scale; DSM: The Diagnostic and Statistical Manual of Mental Disorders; eCBT: Enhanced cognitive behavioral therapy; ERP: Exposure and response prevention; GCP: Good Clinical Practice; iCBT: Internet cognitive behavioral therapy; ISRCTN: International Standard Randomised Controlled Trial Number; IT: Information Technology; K-SADS-PL: The Schedule for Affective Disorders and Schizophrenia for School-Age Children –Present and Lifetime Version; NordLOTS: The Nordic long-term OCD treatment study; OCD: Obsessive Compulsive Disorder; TEQ: Treatment Evaluation Questionnaire; UEQ: User Experience Questionnaire; RCT: Randomized controlled trial.

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Authors' contributions

All authors (LBE, LW, BW, SC, SL and NS) made substantial contributions to the conception and design of the work. LBE and BW contributed to the acquisition of the data. LBE, SL, LW and NS contributed to the analysis of the data. All authors, (LBE, LW, BW, SC, SL and NS) contributed to the interpretation of data. All authors have drafted the work and substantially revised it. All authors (LBE, LW, BW, SC, SL and NS) have approved the submitted version (and any substantially modified version that involves the author's contribution to the study). All authors (LBE, LW, BW, SC, SL and NS) have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature. All authors read and approved the final manuscript.

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Availability of data and materials

The data generated or analysed during this study are included in this published article [and its supplementary information files] and are also available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Regional Committee for Medical and Health Research Ethics (No. 2016/716/REK Nord) and registered with the ISRCTN

(https://www.isrctn.com/) registry (trial ID: ISRCTN37530113). The study procedures were in accordance with the principles of the Declaration of Helsinki [34] and Good Clinical Practice (GCP) standards [35].

Consent for publication
All participants have consented.

Competing interests
The authors declare that they have no competing interests.

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Publisher's Note

PAPER 4

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ORIGINAL ARTICLE

eCBT Versus Standard Individual CBT for Paediatric Obsessive–Compulsive Disorder

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Abstract
Obsessive–compulsive disorder (OCD) is characterized by recurring obsessions and compulsions often with severe impairment affecting 1–3% of children and adolescents. Cognitive behavioural therapy (CBT) is the therapeutic golden standard for paediatric OCD. However, face-to-face CBT is limited by accessibility, availability, and quality of delivery. Enhanced CBT (eCBT) a combination of face-to-face sessions at the clinic and treatment at home via webcam and a supportive app system aims to address some of these barriers. In this pilot study, we compared eCBT outcomes of 25 paediatric patients with OCD benchmarked against traditional face-to-face CBT (n = 269) from the Nordic Long-term OCD Treatment Study, the largest paediatric OCD CBT study to date. Pairwise comparisons showed no difference between eCBT and NordLOTS treatment outcomes. Mean estimate difference was 2.5 in favour of eCBT (95% CI − 0.3 to 5.3). eCBT compared to NordLOTS showed no significant differences between response and remission rates, suggesting similar effectiveness.

Keywords Obsessive–compulsive disorder (OCD) · Cognitive behavioral therapy (CBT) · Enhanced cognitive behavioral therapy (eCBT) · Children · Adolescents

Background

Obsessive–compulsive disorder (OCD), characterized by obsessions and/or compulsions affects 1–3% of children and adolescents [1, 2]. Obsessions include recurrent disturbing thoughts, images, or impulses, and compulsions include repeated behaviours and mental acts, performed to alleviate stress or anxiety [3]. Without treatment, the disorder often leads to functional impairment [4, 5] and reduced quality of life [6]. The gold standard treatment for OCD is cognitive behavioural therapy (CBT) with exposure and response prevention (ERP). Selective serotonin reuptake inhibitors

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(SSRIs) might be added, if deemed necessary [7]. Doubts have been raised about the additional effect of medication [8–10]. CBT as monotherapy led to clinical remission in 39% of the patients in the Pediatric Obsessive–Compulsive Disorder Treatment Study (POTS) [11], and in 49.4% of patients among those who finished the treatment in the Nordic Long-term OCD Treatment Study (NordLOTS), the largest CBT study for paediatric OCD to date [12]. Not all children benefited substantially from the treatment: for example, 66 of 241 (27.4%) patients who completed treatment were classified as non-responders in the NordLOTS [9, 12]. In addition, there are still organizational, ideological, and practical barriers to treatment that limit the availability of CBT and its accessibility for some patients. For example, concerns have been raised about the shortage of experienced therapists, especially in remote areas [13]. There have been previous initiatives attempting to address at least some of the barriers to treatment by using internet CBT. For instance, Storch et al. [14] treated 31 patients in 12 weekly sessions delivered through video teleconferencing (VTC). Findings showed 56.1% reduction of the CY-BOCS total score after 14 sessions of webcam-delivered CBT. Farrell et al. [15] evaluated an intensive treatment consisting of 3 face-to-face CBT sessions, followed by a 3-week maintenance program via webcam for 10 children and youth, using a multiple baseline controlled design. The results showed 49% reduction in the CY-BOCS total score.

With the overall goal of improving access and outcomes, we developed an innovative treatment package for children and adolescents with OCD by integrating internet technology with well-validated principles of CBT. The enhanced CBT (eCBT) manual is derived from the NordLOTS manual and a Dutch CBT manual for paediatric OCD [16, 17]. The eCBT intervention is an innovative treatment package for children and adolescents with OCD. It includes five components which are integrated in the eCBT treatment process: VTC sessions, face-to-face sessions, an app system aimed to support the treatment structure with a psychoeducation tool, reminders and descriptions of exposure exercises, supportive messages, and frequent online ratings which allow direct feedback to the patient. The app system consists of a smartphone app for children and for parents, and a web-based application for therapists on the computer, which are all interconnected. The app provides information about OCD and CBT (psychoeducation videos), supports and structures ERP exercises at home, and closely monitors treatment progress. The eCBT package has been described in detail elsewhere [18]. eCBT aims to enhance traditional CBT (i.e., as delivered in the NordLOTS) by combining face-to-face sessions at the clinic and treatment at home via webcam, and a supportive app system, to facilitate transfer of exposure exercises from the therapist's office to the home environment, improving implementation of ERP in daily life. The main goal of eCBT is to improve treatment satisfaction and compliance, to intensify exposure and response prevention, and ultimately to improve treatment outcomes. Both motivation and good technique is crucial for exposure work. In addition, homework completion is an important component of ERP. A review of homework completion in ERP [19] concluded that future work on technology use with ERP homework is warranted. Children often show most commitment to their homework in the first days after a treatment session, and then efforts gradually decrease. Scheduled phone calls with the therapist appeared to improve homework completion in a study with adults [20]. A combination of face-to-face sessions with in-between webcam sessions at home offers a possibility to follow up and to carry out therapist-assisted exposure exercises in the patient's home. This may increase motivation and improve exposure technique, treatment intensity, and homework completion. The app offers a scaffolding construction for the treatment, while making use of children's and adolescents' affinity with internet technology. For patients and parents, this higher treatment intensity is achieved with less effort, because the number of face-to-face sessions demanding transport, parking, time off from school for the children and from work for the parents was reduced, and partly replaced by webcam sessions at home. A preliminary evaluation of acceptability and feasibility suggested that eCBT was highly accepted and feasible. Children's and parents' feedback on the Client Satisfaction Questionnaire-8 yielded mean scores of 27.58 (SD 0.67) for children and 29.5 (SD 3.74) for parents (range 8–32) and none of the participants dropped out from treatment [21].

The aim of the present study is to evaluate the effectiveness of eCBT, an Internet-enhanced version of the earlier NordLOTS CBT. For this reason, we compared eCBT with NordLOTS CBT outcomes in a pilot open trial benchmarked against NordLOTS as a first step. The NordLOTS established effectiveness and feasibility of CBT for OCD in the context of the Scandinavian healthcare system, including both specialized OCD clinics and general child psychiatric outpatient clinics [22, 23]. Because of the similarities in assessment and sample characteristics, we used the established NordLOTS outcome standards as a reference frame for comparison with eCBT outcomes. Our hypothesis is that the eCBT efficacy results are noninferior to results found in the NordLOTS.

Methods

Participants

Inclusion criteria were identical in both studies, with the exception that patients with OCD and comorbid autism spectrum disorder (ASD) were not excluded from eCBT

study. For an overview of inclusion and exclusion criteria for eCBT and NordLOTS see Table 1. The patient recruitment process is detailed in a flowchart (Fig. 1).

eCBT

The eCBT study was conducted in child and adolescent mental health services (CAMHS), St. Olav's University Hospital, Trondheim, Norway (n = 23) and CAMHS, Hospital of Aalesund, Norway (n = 2). A total of 82 children

Table 1 Inclusion and Exclusion criteria for eCBT and NordLOTS studies

eCBT	NordLOTS
Inclusion criteria	
Primary DSM-5 diagnosis of OCD	Primary DSM-IV diagnosis of OCD
CY-BOCS entry score of 16 or above	CY-BOCS entry score of 16 or above
7–17 years of age	7–17 years of age
Patients with OCD, ASD, and ADHD eligible	Patients with OCD and ADHD eligible, after having been stabilized on medication for at least 3 months prior to entry
Exclusion criteria	
Presence of other psychiatric disorders (according to the DSM-5) with higher treatment priority (i.e., primary anorexia nervosa, psychosis, severe depression)	Presence of other psychiatric disorders (according to the DSM-5) with higher treatment priority (i.e., primary anorexia nervosa, psychosis, severe depression)
Intellectual disability	Intellectual disability ASD (PDD-NOS was allowed if OCD symptoms were most impairing)
Ongoing psychological treatment for OCD	A previous trial of exposure-based CBT for OCD less than 6 months prior to inclusion
	Medication treatment with an SSRI less than 6 months prior to inclusion
Inadequate language proficiency by the patient or the parent	Inadequate language proficiency by the patient or the parent

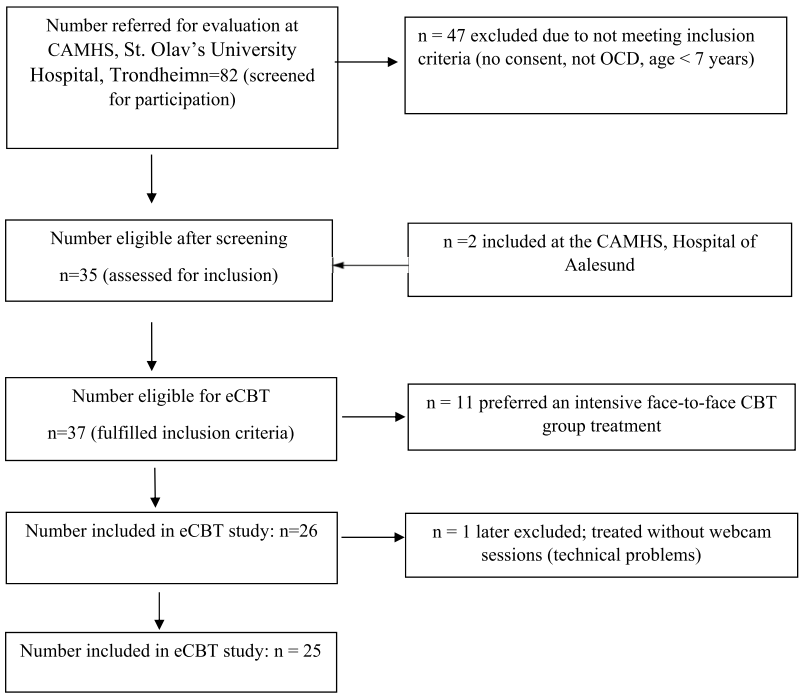

Fig. 1 Patient recruitment flowchart

and adolescents with suspected OCD were referred to CAMHS, St. Olav's University Hospital, Trondheim between January 2018 and November 2019 and evaluated for participation in the study. Of these, 47 did not fulfil inclusion criteria. Twenty-six of the 37 eligible patients (70%) were informed about the eCBT study and agreed to participate, 11 (30%) preferred an intensive face-to-face CBT group treatment. The first patient included in the study did not have webcam sessions due to technical problems and was excluded from analyses (Fig. 1). As a result, the final sample consisted of 25 participants. All twenty-five participants completed the treatment. Mean age of participants (N = 25) was 13.1 years (SD 2.9), with slightly more female (56%) than male participants, and 97% having a Scandinavian background.

NordLOTS

A total of 269 children and adolescents, recruited at five main study sites in Denmark, Sweden, and Norway between September 2008 and June 2012, were included in the NordLOTS. Assessment and treatment were performed in 18 public community mental health clinics with general referrals and at two specialized OCD clinics (Aarhus, Denmark, and Gothenburg, Sweden) [12].

Participants' characteristics are reported in Table 2. At baseline, the mean age of the NordLOTS participants was 12.8 years (SD 2.7 years, range 7–17), and 51.3% were girls. Ethnicity was primarily Scandinavian: 97% of the participants had one or both parents of Scandinavian origin.

In the NordLOTS, 269 patients were offered CBT, and 241 (89.6%) completed the treatment.

Table 2 Patient characteristics

Variable	NordLOTS	eCBT	*p*-value
n	269	25	–
Age, year, mean (SD)	12.8 (2.7)	13.1 (2.9)	0.598
Age of OCD onset, year (SD)	11.7 (3.0)	9.7 (3.7)	**0.002**
Female participants, n (%)	138 (51.3)	14 (56.0)	0.653
Male participants, n (%)	131 (48.7)	11 (44.0)	
Family status, n (%)			
Parents living together, n (%)	173 (64.3)	21 (84.0)	**0.047**
Other, n (%)	95 (35.3)	4 (16.0)	
CY-BOCS, mean (SD)			
Total score at baseline	24.6 (5.1)	25.8 (5.4)	
Obsession score at baseline	12.3 (2.8)	13.1 (2.7)	0.147
Compulsion score at baseline	12.3 (2.7)	12.6 (3.1)	0.553
Comorbid disorders at baseline (K-SADS PL)			
Any anxiety disorder, n (%)	52 (19.3)	6 (24.0)	0.572
Any depressive disorder, n (%)	10 (3.7)	1 (4.0)	0.939
ADHD, n (%)	24 (8.9)	3 (12.0)	0.608
ODD/CD, n (%)	10 (3.7)	0 (0)	–
Tic disorder, n (%)	49 (18.2)	4 (16.0)	0.785
ASD, n (%)	1 (0.4)	4 (16.0)	**< 0.001**
Encopresis, n (%)	0 (0)	1 (4.0)	–
PTSD, n (%)	1 (0.4)	2 (8.0)	**< 0.001**
Eating disorder, n (%)	0 (0)	2 (8.0)	–
Number of co-occurring diagnoses, n (%)			0.072
None	163 (62.8)	13 (52.0)	
1	62 (23.0)	8 (32.0)	
2	25 (9.3)	2 (8.0)	
≥ 3	13 (4.9)	2 (8.0)	

Significant differences ($p < 0.05$) are indicated with boldface

ADHD attention deficit/hyperactivity disorder, *CD* conduct disorder, *CY-BOCS* Children's Yale-Brown Obsessive–Compulsive Scale, *K-SADS-PL* Kiddie schedule for affective disorders and schizophrenia—present and lifetime version, *OCD* obsessive–compulsive disorder, *ODD* oppositional defiant disorder, *NA* non-applicable

Treatment

NordLOTS

NordLOTS treatment consisted of 14 sessions of weekly individual manualized CBT with ERP, based on the study protocol of March et al. [24] and modified by adding more extensive family participation [25] and adapted to fit Nordic cultural conditions [17]. The first sessions of the treatment included psychoeducation about OCD and treatment strategies and socializing to the treatment model of gradual exposure to threatening situations. For more detailed information about the NordLOTS treatment, see [12, 26, 27].

eCBT

The basic content of the eCBT treatment manual was comparable with the manual used in the NordLOTS. Like the NordLOTS, eCBT contains psychoeducation, ERP, cognitive interventions, and relapse prevention, with the focus on ERP.

In eCBT, 5 closely linked components are integrated: webcam sessions in combination with face-to-face sessions, an app system, a psychoeducation tool, and frequent online ratings with direct feedback to the patient. Another difference is the distribution of treatment sessions over time: the eCBT treatment protocol consisted of up to 10 weekly face-to-face sessions, combined with up to 12 shorter webcam sessions, delivered over a 14-week period. In eCBT, parents were involved by default. For a more detailed description of the eCBT treatment manual, see Wolters et al. [18].

Measures

The same measures were used in both the eCBT study and NordLOTS.

The Schedule for Affective Disorders and Schizophrenia—Present and Lifetime version (K-SADS-PL) is a widely used standardized diagnostic interview for the assessment of psychiatric disorders in children and adolescents [28]. The instrument was used both to confirm OCD diagnoses and to evaluate the presence of comorbidity. The K-SADS-PL has excellent inter-rater reliability [29] and validity [30, 31].

The Children's Yale-Brown Obsessive–Compulsive Scale (CY-BOCS) [32] is a semi-structured interview developed for the assessment of OCD symptoms in children and adolescents. The instrument consists of a subscale for obsessions and another for compulsions, scored by the clinician, based on interviews with each child and parent or caregiver informant. The CY-BOCS total score (range 0–40) is the sum of the subscale scores (range 0–20) for obsessions and compulsions. The CY-BOCS showed reasonable reliability and validity, high internal consistency ($\alpha = 0.90$) and test–retest reliability (ICC 0.79 for the total score), and good inter-rater agreement (ICC 0.84 for the total score) [33, 34].

Statistical Analysis

Participants with missing and non-missing data were compared by baseline CY-BOCS total score, sex, age, age of onset, and comorbidity. None of these comparisons showed significant differences at baseline, and no differences were found between participants with and without missing data. For that reason, we considered missing data as missing at random.

We computed the percentage of patients with OCD symptoms in the clinical range (CY-BOCS ≥ 16) and in remission (remission defined as CY-BOCS ≤ 12), and the percentage of treatment responders (treatment response defined as $\geq 35\%$ symptom reduction on the CY-BOCS plus CGI-I (Clinical Global Impressions scale—Improvement') rating of 1 or 2 "(very) much improved"). Effect size (d) was calculated by the mean difference CY-BOCS score pre- versus post-eCBT, divided by the standard deviation of the difference score pre- versus- post-eCBT.

We used linear mixed models (LMMs) to evaluate outcome changes on the CY-BOCS total score [35, 36]. The model included all available data to estimate model parameters. LMMs are commonly recommended both for superiority and noninferiority analyses because of their ability to handle missing data and correlated and repeatedly measured observations [37]. We used restrictive maximum likelihood estimation and included fixed effects for time (baseline and week 14), treatment cohort (NordLOTS vs. eCBT), and their interaction. The model included random effects for intercept. An unstructured covariance was used to account for correlated observations. For benchmarking against NordLOTS, we explored noninferiority following current guidelines [38]. An important part of a noninferiority calculation is to examine the inferiority margin [38]. We determined whether eCBT was inferior to the NordLOTS results by using the confidence interval (CI). If the lower limit of the two-sided 95% CI of the difference of the mean is less than the noninferiority margin (pre-specified), we can establish noninferiority [37, 38]. We set noninferiority at 4 points on the CY-BOCS scale using a 95% CI. eCBT would be non-inferior to the NordLOTS CBT if the upper limit of the 95% CI for the difference between eCBT and the NordLOTS CBT were less than 4. This means that we would be 95% confident that the real value of the difference between these cohorts (at week 14) was not worse than 4 points on the CY-BOCS total score.

Multivariate χ^2 tests were conducted on binary outcomes (e.g., remission). Multiple imputation was used to replace missing data. This was done with a sequential regression multivariate imputation algorithm [39]. This imputation model included all baseline demographics and

outcome measures, and a total of 20 multiple imputations were generated according to guidelines [40, 41]. The SAS 9.4 proc mi was used to generate the 20 imputation datasets. Outcomes reported were calculated using Rubin's rules [39] to combine the results of the 20 identical analyses, using the SAS 9.4 proc MIANALYZE procedure. This was done on each of the 20 imputed datasets, and the results were combined and reported as an F statistic. Tests were two-tailed, and a p-value of less than 0.05 was considered to indicate statistical significance. The computation of a combined F statistic was conducted with the SAS macro COMBCHI [42]. We used SAS statistical software, version 9.4 to conduct the LME (using the proc mixed procedure) and multiple imputation. All other analyses were performed using SPSS version 26.0.

Calculation of Sample Size

To explore noninferiority in this pilot open trial benchmarked against NordLOTS, power calculations indicate that 4 points on the CY-BOCS total score means that 21 participants in the eCBT group would be sufficient to show noninferiority, with alpha = 0.05 and beta 0.20.

Results

Patient Characteristics

At baseline, the mean CY-BOCS total score was 24.6 (SD 5.1) for NordLOTS and 25.8 (SD 5.4) for eCBT (Table 2). Statistically significant differences between groups were present for age of onset of OCD, with mean age of OCD onset 11.7 years (SD 3.00) in the NordLOTS and M 9.7 (SD 3.7) in the eCBT sample $t(291) = -3.131$, $p = 0.002$). ASD $t(291) = 32.697$, $p < 0.001$, and PTSD $t(291) = 12.718$, $p < 0.001$ were more frequent in the eCBT sample. We found no statistical differences between groups for baseline CY-BOCS, family status, other comorbid disorders, or a number of co-occurring diagnoses at baseline. Two eCBT patients were receiving concurrent medication for non-OCD psychological disorders (guanfacine and risperidone). None of the patients received any medication for OCD. For two patients it was difficult to keep up webcam sessions due to comorbid problems, i.e., ASD and eating disorder, resulting in only one completed webcam session for each participant. Both patients received four extra face-to-face sessions to compensate for therapist time. Another patient received 11 face-to-face sessions instead of the protocolized 10 sessions, which included treatment of a comorbid specific phobia.

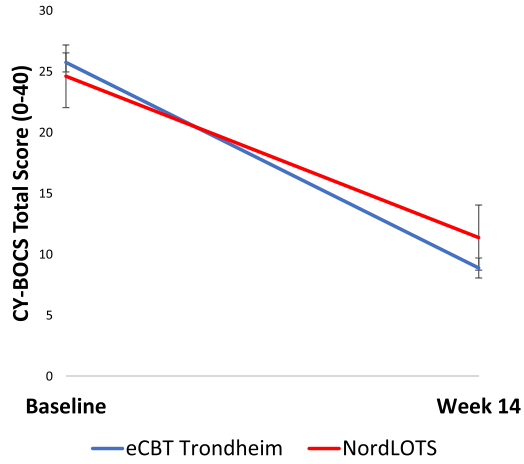

Fig. 2 Adjusted intent-to-treat CY-BOCS total score across treatment cohorts

Table 3 Parameter estimates from fitting elevation and slope to the CY-BOCS

Parameter	Final model
Composite model, estimate (SE)	
Intercept	25.760 (1.304)***
Weeks	− 1.205 (0.121)***
Group	− 1.136 (1.363)
Week*group	0.259 (0.127)*
Variance components	
Level-1—within person	34.317 (2.929)***
Level-2—in initial status	8.174 (2.597)***

*p < 0.05, ***p < 0.001

Outcomes

Adjusted intent-to-treat CY-BOCS total scores across treatment cohorts are shown in Fig. 2. Pairwise comparisons post-treatment showed that the difference between eCBT and NordLOTS treatment outcomes was not statistically significant [$t(264) = 1.76$, $p = 0.08$]. The mean estimate difference was 2.5 (in favour of eCBT), with the 95% CI between − 0.3 and 5.3. Further information on parameter estimates may be found in Table 3.

The estimated change in mean CY-BOCS total scores from baseline to posttreatment was significantly greater in the eCBT group than in NordLOTS (change in mean difference = 3.6) [$t(264) = 2.04$, $p = 0.04$] (Table 4).

A total of 59.6% of participants in the NordLOTS and 68.0% of participants in the eCBT cohort responded to

Table 4 Posttreatment group-specific outcomes and response rates

Primary outcomes	Estimated mean or rate (95% CI)[a]		Effect sizes (95% CI)[b c]
	eCBT	NordLOTS	
CY-BOCS total score	8.9 (6.2, 11.6)	11.4 (10.6, 12.2)	0.35 (−0.06, 0.76)
Reduction from baseline CY-BOCS total score	−16.9 (−20.2,13.5)	−13.2 (−12.2, −14.3)	0.41 (0.00, 0.82)
Symptoms in clinical range (CYBOCS ≥ 16)	24.0% (9.4%, 45.1%)	29.1% (23.3%, 34.8%)	0.11 (−0.29, 0.52)
Remission (CY-BOCS ≤ 12)	68.0% (46.1%, 89.9%)	57.6% (51.4%, 63.8%)	0.21 (0.20, 0.62)
Response rate	68.0% (46.5%, 85.1%)	59.6% (53.5%, 65.8%)	0.17 (−0.24, 0.58)
Attrition rate	1 (4.0%)	26 (10.7%)	

[a]For CY-BOCS total score, estimated mean score at posttreatment from the fitted LMM. For the categorical outcomes, the estimated rate at posttreatment

[b]For CY-BOCS total score, the between-groups difference in estimated mean score at posttreatment. For the categorical outcomes, between-groups difference in rate at posttreatment

[c]Positive effect size suggests that eCBT was more effective

treatment. The multivariate χ^2 test showed no statistically significant differences between groups ($p = 0.415$).

We also examined differences in attrition and remission rates. Attrition rates were similar, with no significant differences between groups (χ^2 (1, 293) = 0.880, $p = 0.348$). Remission rates were 68.0% for the eCBT group and 57.6% for the NordLOTS group. The multivariate χ^2 test showed no statistically significant differences between the groups ($p = 0.317$).

Lastly, we examined differences in the number of participants with symptoms still within the clinical range (CY-BOCS total score 16 or above) at posttreatment. In the eCBT group 24.0% of participants were still within the clinical range, compared with 29.1% in the NordLOTS group. This difference was not significant ($p = 0.593$).

Discussion

The aim of this study was to examine the effectiveness of eCBT by comparing the outcomes with historical outcomes of well-established traditional CBT for paediatric OCD. eCBT offers traditional CBT in an enhanced format, including additional webcam sessions for therapist-assisted exposure exercises at home and a supportive app system. As a first step in examining the efficacy of this newly developed protocol, we compared eCBT with standard CBT delivered face-to-face, by benchmarking the results against NordLOTS, the largest study to date on the effectiveness of CBT for paediatric OCD. The results show that eCBT is at least equally effective as the NordLOTS.

eCBT and NordLOTS samples were comparable in terms of OCD severity scores at baseline, male to female ratio, family setting, and rate of comorbidity. Differences existed in the inclusion of ASD in the eCBT study, while this was an exclusion criterion in the NordLOTS sample. However, Pervasive Development Disorder—Not Otherwise Specified (PDD-NOS) was allowed in the NordLOTS if symptoms of OCD were most impairing; hence there was one patient also with ASD in the NordLOTS sample. Four of the 25 participants included in the eCBT group had a diagnosis of ASD. In addition, age and age of OCD onset were slightly lower in the eCBT group than in the NordLOTS sample.

The mean estimated difference of CY-BOCS total scores −2.5 (95% CI −0.3 to −5.3) was not statistically significant within the 4-point difference margin. The estimated change in mean CY-BOCS total scores from baseline to posttreatment was significantly greater in the eCBT group than in NordLOTS. This could indicate that eCBT might be more effective in reducing OCD symptoms than standard CBT. However, these results need to be considered preliminary, and need to be properly examined using a randomized controlled trial with head-to-head comparison. We found no significant differences between response and remission rates in the respective studies.

Attrition rates did not differ significantly between eCBT and NordLOTS (4.0% versus 10.7% respectively; $p = 0.289$), which indicates that eCBT offers a feasible format for most participants, comparable to standard CBT. As already mentioned, the eCBT sample included 4 participants (16.0%) with ASD. All four had large reductions in pre to post CY-BOCS scores (34/17, 21/0, 18/12 and 25/0). Treatment of children and adolescents with OCD and ASD has been associated with lower response rates [43]. A review of the effectiveness of CBT for individuals with ASD and comorbid OCD concluded that standard CBT needs to be modified to address special needs of children with ASD, for example increased structure in the sessions, visual aids and cues, and considerable parental involvement [44]. Although these results are very preliminary, the first impression is that

eCBT could offer a suitable format for children with ASD and comorbid OCD. The very positive outcome of eCBT in a few patients with ASD and OCD could be a promising direction for future research. Hopefully, future studies will be able to determine if components of eCBT, such as facilitating individual adjustments, transfer from the office to the home environment, and the possibility of therapist-assisted exposure work via webcam at home, may make this treatment appealing for children with OCD and ASD.

It is relevant to compare the results for eCBT with results from other Internet-enhanced CBT programs for paediatric OCD. The results for eCBT with 65.5% reduction of CY-BOCS total score from baseline to posttreatment evaluation seem to be in line with other studies using Internet technology to deliver CBT for children with OCD [45]. For example reported the mentioned studies by Storch et al. [14] 56.1% reduction of CY-BOCS total score after webcam-delivered CBT and Farrell et al. [15] 49% reduction of CY-BOCS score after three face-to-face CBT sessions, followed by a 3-week maintenance program via webcam. Other studies applying various degrees of Internet technology to deliver CBT to children with OCD reported somewhat lower reductions in CY-BOCS scores after treatment [45].

eCBT may help increase access to treatment by reducing geographical barriers and facilitating expert treatment by providing part of the treatment at home via webcam sessions. Although eCBT is not fully remote, the fewer number of face-to-face sessions limits travelling time and costs and may make treatment more patient-friendly and easier accessible even when patients live in distance from a qualified therapist. Previous results suggested that eCBT offers an acceptable and feasible treatment format; no major barriers to treatment were reported by participants or therapists [21]. Another advantage of eCBT is that exposure exercises can be performed in a naturalistic environment where the symptoms are most prevalent (usually at home) and directly modelled and supervised by the therapist. Practising and implementing exposure in daily life is essential for a successful treatment. Adapting the treatment schedule to individual needs, including online support from the therapist when practising exposure at home, may have the potential to reduce treatment failure and dropouts.

eCBT was conceptualized and data were acquired prior to the COVID-19 pandemic when safe online treatment was less common. The COVID-19 pandemic has catalyzed digital transformation in all aspects of our society, including CAMHS. The pandemic crisis underlined the need for treatment without direct contact during critical times. In addition, delivering larger treatment parts via webcam at home offers both more convenient treatment as well as easier access to treatment, and more possibilities for offering therapist-assisted exposure exercises in the patient's home environment.

Strengths and Limitations

A strength of this study is that similar sample characteristics facilitate comparison between samples. Both samples included patients with comparable degrees of OCD severity and comorbid disorders. The same assessment methods, with independent evaluators and similar treatment strategies, were used in both studies. In addition, the treatment concept of eCBT is derived from NordLOTS CBT and a similar Dutch treatment protocol, and differences regarding treatment delivery were well defined.

Main limitations include a small eCBT sample size and the absence of a direct comparison group. These limitations derive from the concept of the eCBT study as a pilot feasibility trial whose aim was to explore preliminary effectiveness, before continuing with randomized and controlled studies which demand much larger resources.

In this paper we report on and compare acute eCBT outcomes posttreatment. NordLOTS documented that the treatment gains were durable over a follow-up period of 3 years [23]. Also, for eCBT follow-up, observations will be necessary to study whether the treatment gains remain stable over time.

Summary

The present study explores the preliminary effectiveness of enhanced CBT (eCBT) for children and adolescents with OCD. eCBT is a combination of face-to-face sessions at the clinic and treatment at home via webcam and a supportive app system aimed to address limitations to standard face-to-face CBT as accessibility, availability, and quality of delivery. In this pilot open trial, we compared eCBT outcomes of 25 paediatric patients with OCD benchmarked against standard face-to-face CBT (n = 269) from the Nordic Long-term OCD Treatment Study, the largest paediatric OCD CBT study to date. eCBT compared to NordLOTS showed no significant differences between response and remission rates, suggesting similar effectiveness. The mean estimate difference was 2.5 in favour of eCBT (95% CI − 0.3 to 5.3). As we found a significantly higher mean reduction of CY-BOCS scores in the eCBT group, it may have the potential to be more effective in reducing OCD symptoms than standard CBT. However, this latter finding needs to be examined in randomized head-to-head comparisons between groups and on a larger scale.

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Author Contributions All authors (LBE, GS, BW, LW, SC, TI and NS) made substantial contributions to the conception and design of the work. LBE and BW contributed to the acquisition of the data. LBE and GS contributed to the analysis of the data. All authors, (LBE, GS, BW, LW, SC, TI and NS) contributed to the interpretation of data. All authors have drafted the work and substantially revised it. All authors (LBE, GS, BW, LW, SC, TI and NS) have approved the submitted version (and any substantially modified version that involves the author's contribution to the study). All authors (LBE, GS, BW, LW, SC, TI and NS) have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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Data Availability The data and materials are available from the corresponding author on reasonable request.

Declarations

Conflict of interest Declarations Conflict of interest: Dr. Weidle has received royalties from book Publishers Gyldendal and Universitetsforlaget for co-authorship of books on OCD and Child and Adolescent Psychiatry. The rest of the co-authors have nothing to declare.

Consent for Publication All participants have given written consent.

Ethical Approval The study was approved by the Regional Committee for Medical and Health Research Ethics (No2016/716/REK Nord) and registered with the ISRCTN (https://www.isrctn.com/) registry (trial ID: ISRCTN37530113). The study procedures were in accordance with the principles of the Declaration of Helsinki [46] and Good Clinical Practice (GCP) standards [47].

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Chapter 7: Appendixes paper 1

7.1. Systematic review search strategy

The starting point, this systematic review uses the first paper about OCD treatment involving computer technology which was published in 1987 (Baer et al., 1987). Therefore, studies published from 1987 to March 2018 were deemed eligible. The first step was to check the Cochrane database to make sure that an equivalent systematic review on this subject had not already been published. We then searched EMBASE, Medline, PsycINFO, CENTRAL, LILACS, CINAHL, and Scopus for relevant studies. Three co-authors (VS, SP and LBE) conducted the initial database research, and two co-authors (LW and LBE) filled in the data collections forms that had been developed *a priori* by VB. The data collection forms comprised four key sections. First, general information about the study: publication type, country of origin and funding. Second, whether the study was eligible for the review: inclusion criteria, sample details, study design, types of intervention and reasons to exclude the study. Third, the study characteristics: aim, design, participants, outcomes. Fourth, the risk of bias assessment. Three co-authors (LW, LBE and NS) assessed the eligibility of the papers. The conference proceedings of events held by leading societies were scrutinised for relevant references to reduce potential limitations of the systematic database search. These were the World Confederation of Cognitive and Behavioural Therapies (WCBCT), European Association for Behavioural and Cognitive Therapies (EABCT), European Society for Child and Adolescent Psychiatry (ESCAP), Association for Behavioral and Cognitive Therapies (ABCT), American

Academy of Child and Adolescent Psychiatry (AACAP), International Association for Child and Adolescent Psychiatry and Allied Professions (IACAPAP), International Conference on Child and Adolescent Psychopathology (ICCAP), British Association for Behavioural & Cognitive Psychotherapies (BABCP) and International College of Obsessive Compulsive Spectrum Disorders (ICOCS).

Finally, relevant Cochrane reviews, the WHO trials portal, the International Clinical Trials Registry platform, (ICTRP), ClinicalTrials.gov, and Google Scholar were searched to identify additional studies.

Medline via OVID

Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) <1946 to Present>

#	Searches
1	exp Obsessive-Compulsive Disorder/
2	ocd.ti,ab,kw.
3	obsess*.ti,ab,kw.
4	compulsi*.ti,ab,kw.
5	or/1-4
6	exp Telemedicine/
7	exp Electronic Mail/
8	exp Telephone/
9	exp Videoconferencing/
10	exp Internet/
11	exp Computers/
12	exp Software/
13	exp Decision Making, Computer-Assisted/
14	smartphone*.ti,ab,kw.
15	telephone*.ti,ab,kw.
16	computer*.ti,ab,kw.

17 distance*.ti,ab,kw.
18 remote.ti,ab,kw.
19 internet*.ti,ab,kw.
20 telepsychiatry.ti,ab,kw.
21 telepsychology.ti,ab,kw.
22 telemental.ti,ab,kw.
23 telehealth.ti,ab,kw.
24 teletherapy.ti,ab,kw.
25 cybercounseling.ti,ab,kw.
26 (web adj2 based).ti,ab,kw.
27 "web based".ti,ab,kw.
28 phone*.ti,ab,kw.
29 mobile*.ti,ab,kw.
30 "e mail*".ti,ab,kw.
31 email*.ti,ab,kw.
32 "electronic mail*".ti,ab,kw.
33 online.ti,ab,kw.
34 "on line".ti,ab,kw.
35 videoconferenc*.ti,ab,kw.
36 "video conferenc*".ti,ab,kw.
37 (chat adj2 room*).ti,ab,kw.
38 "chat room*".ti,ab,kw.
39 (instant adj2 messaging).ti,ab,kw.
40 "instant messaging".ti,ab,kw.
41 iCBT.ti,ab,kw.
42 iCBTs.ti,ab,kw.
43 "social media?".ti,ab,kw.
44 or/6-43
45 exp Child/
46 exp Adolescent/
47 child*.ti,ab,kw.
48 teen*.ti,ab,kw.
49 (young adj2 people*).ti,ab,kw.
50 "young people*".ti,ab,kw.
51 (young adj2 person*).ti,ab,kw.

52 "young person*".ti,ab,kw.
53 girl*.ti,ab,kw.
54 boy*.ti,ab,kw.
55 minor*.ti,ab,kw.
56 kid*.ti,ab,kw.
57 juvenile*.ti,ab,kw.
58 youth.ti,ab,kw.
59 adolesc*.ti,ab,kw.
60 p?ediatri*.ti,ab,kw.
61 or/45-60
62 5 and 44 and 61
63 limit 62 to yr="1987 -Current"

Cochrane Library

ID Search Hits
#1 MeSH descriptor: [Obsessive-Compulsive Disorder] explode all trees
#2 "ocd":ti,ab,kw (Word variations have been searched)
#3 obsess*:ti,ab,kw (Word variations have been searched)
#4 compulsi*:ti,ab,kw (Word variations have been searched)
#5 #1 or #2 or #3 or #4
#6 MeSH descriptor: [Telemedicine] explode all trees
#7 MeSH descriptor: [Electronic Mail] explode all trees
#8 MeSH descriptor: [Telephone] explode all trees
#9 MeSH descriptor: [Videoconferencing] explode all trees
#10 MeSH descriptor: [Internet] explode all trees
#11 MeSH descriptor: [Software] explode all trees
#12 MeSH descriptor: [Computers] explode all trees
#13 MeSH descriptor: [Decision Making, Computer-Assisted] explode all trees
#14 smartphone*:ti,ab,kw (Word variations have been searched)
#15 telephone*:ti,ab,kw (Word variations have been searched)
#16 computer*:ti,ab,kw (Word variations have been searched)
#17 distance*:ti,ab,kw (Word variations have been searched)
#18 remote:ti,ab,kw (Word variations have been searched)
#19 internet*:ti,ab,kw (Word variations have been searched)
#20 telepsychiatry:ti,ab,kw (Word variations have been searched)
#21 telepsychology:ti,ab,kw (Word variations have been searched)
#22 telemental:ti,ab,kw (Word variations have been searched)
#23 telehealth:ti,ab,kw (Word variations have been searched)
#24 teletherapy:ti,ab,kw (Word variations have been searched)
#25 cybercounseling:ti,ab,kw (Word variations have been searched)

#26 (web near/2 based):ti,ab,kw (Word variations have been searched)
#27 phone*:ti,ab,kw (Word variations have been searched)
#28 mobile*:ti,ab,kw (Word variations have been searched)
#29 "e mail*":ti,ab,kw (Word variations have been searched)
#30 email*:ti,ab,kw (Word variations have been searched)
#31 "electronic mail*":ti,ab,kw (Word variations have been searched)
#32 online:ti,ab,kw (Word variations have been searched)
#33 "on line":ti,ab,kw (Word variations have been searched)
#34 videoconferenc*:ti,ab,kw (Word variations have been searched)
#35 "video conferenc*":ti,ab,kw (Word variations have been searched)
#36 (chat near/2 room*):ti,ab,kw (Word variations have been searched)
#37 (instant near/2 messaging):ti,ab,kw (Word variations have been searched)
#38 iCBT:ti,ab,kw (Word variations have been searched)
#39 iCBTs:ti,ab,kw (Word variations have been searched)
#40 "social media*":ti,ab,kw (Word variations have been searched)
#41 #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40
#42 MeSH descriptor: [Child] explode all trees
#43 MeSH descriptor: [Adolescent] explode all trees
#44 child*:ti,ab,kw (Word variations have been searched)
#45 teen*:ti,ab,kw (Word variations have been searched)
#46 (young near/2 people*):ti,ab,kw (Word variations have been searched)
#47 (young near/2 person*):ti,ab,kw (Word variations have been searched)
#48 girl*:ti,ab,kw (Word variations have been searched)
#49 boy*:ti,ab,kw (Word variations have been searched)
#50 minor*:ti,ab,kw (Word variations have been searched)
#51 kid*:ti,ab,kw (Word variations have been searched)
#52 juvenile*:ti,ab,kw (Word variations have been searched)
#53 youth:ti,ab,kw (Word variations have been searched)
#54 adolesc*:ti,ab,kw (Word variations have been searched)
#55 pediatri*:ti,ab,kw (Word variations have been searched)
#56 paediatri*:ti,ab,kw (Word variations have been searched)
#57 #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49 or #50 or #51 or #52 or #53 or #54 or #55 or #56
#58 #5 and #41 and #57

EMBASE via OVID

Embase <1974 to 2017 June 26>

#	Searches
1	exp Obsessive-Compulsive Disorder/

2 ocd.ti,ab,kw.
3 obsess*.ti,ab,kw.
4 compulsi*.ti,ab,kw.
5 or/1-4
6 exp Telehealth/
7 exp Mass communication/
8 exp Software/
9 exp Computer/
10 exp Computer-assisted therapy/
11 smartphone*.ti,ab,kw.
12 telephone*.ti,ab,kw.
13 computer*.ti,ab,kw.
14 distance*.ti,ab,kw.
15 remote.ti,ab,kw.
16 internet*.ti,ab,kw.
17 telepsychiatry.ti,ab,kw.
18 telepsychology.ti,ab,kw.
19 telemental.ti,ab,kw.
20 telehealth.ti,ab,kw.
21 teletherapy.ti,ab,kw.
22 cybercounseling.ti,ab,kw.
23 (web adj2 based).ti,ab,kw.
24 "web based".ti,ab,kw.
25 phone*.ti,ab,kw.
26 mobile*.ti,ab,kw.
27 "e mail*".ti,ab,kw.
28 email*.ti,ab,kw.
29 "electronic mail*".ti,ab,kw.
30 online.ti,ab,kw.
31 "on line".ti,ab,kw.
32 videoconferenc*.ti,ab,kw.
33 "video conferenc*".ti,ab,kw.
34 (chat adj2 room*).ti,ab,kw.
35 "chat room*".ti,ab,kw.
36 (instant adj2 messaging).ti,ab,kw.

37 "instant messaging".ti,ab,kw.
38 iCBT.ti,ab,kw.
39 iCBTs.ti,ab,kw.
40 "social media?".ti,ab,kw.
41 or/6-40
42 exp Child/
43 exp Adolescent/
44 child*.ti,ab,kw.
45 teen*.ti,ab,kw.
46 (young adj2 people*).ti,ab,kw.
47 "young people*".ti,ab,kw.
48 (young adj2 person*).ti,ab,kw.
49 "young person*".ti,ab,kw.
50 girl*.ti,ab,kw.
51 boy*.ti,ab,kw.
52 minor*.ti,ab,kw.
53 kid*.ti,ab,kw.
54 juvenile*.ti,ab,kw.
55 youth.ti,ab,kw.
56 adolesc*.ti,ab,kw.
57 p?ediatri*.ti,ab,kw.
58 or/42-57
59 5 and 41 and 58
60 limit 59 to yr="1987 -Current"

PsycINFO via OVID

PsycINFO <1987 to June Week 3 2017>

#	Searches
1	exp Obsessive Compulsive Disorder/
2	ocd.ti,ab,id.
3	obsess*.ti,ab,id.
4	compulsi*.ti,ab,id.
5	or/1-4
6	exp Telemedicine/
7	exp Computers/

8 exp Computer Software/
9 exp Computer Applications/
10 exp Computer conferencing/
11 exp Internet/
12 exp Telecommunications Media/
13 exp Electronic Communication/
14 exp Internet Usage/
15 exp Online Therapy/
16 smartphone*.ti,ab,id.
17 telephone*.ti,ab,id.
18 computer*.ti,ab,id.
19 distance*.ti,ab,id.
20 remote.ti,ab,id.
21 internet*.ti,ab,id.
22 telepsychiatry.ti,ab,id.
23 telepsychology.ti,ab,id.
24 telemental.ti,ab,id.
25 telehealth.ti,ab,id.
26 teletherapy.ti,ab,id.
27 cybercounseling.ti,ab,id.
28 (web adj2 based).ti,ab,id.
29 "web based".ti,ab,id.
30 phone*.ti,ab,id.
31 mobile*.ti,ab,id.
32 "e mail*".ti,ab,id.
33 email*.ti,ab,id.
34 "electronic mail*".ti,ab,id.
35 online.ti,ab,id.
36 "on line".ti,ab,id.
37 videoconferenc*.ti,ab,id.
38 "video conferenc*".ti,ab,id.
39 (chat adj2 room*).ti,ab,id.
40 "chat room*".ti,ab,id.
41 (instant adj2 messaging).ti,ab,id.
42 "instant messaging".ti,ab,id.

43 iCBT.ti,ab,id.
44 iCBTs.ti,ab,id.
45 "social media?".ti,ab,id.
46 or/6-45
47 child*.ti,ab,id.
48 teen*.ti,ab,id.
49 (young adj2 people*).ti,ab,id.
50 "young people*".ti,ab,id.
51 (young adj2 person*).ti,ab,id.
52 "young person*".ti,ab,id.
53 girl*.ti,ab,id.
54 boy*.ti,ab,id.
55 minor*.ti,ab,id.
56 kid*.ti,ab,id.
57 juvenile*.ti,ab,id.
58 youth.ti,ab,id.
59 adolesc*.ti,ab,id.
60 p?ediatri*.ti,ab,id.
61 or/47-60
62 5 and 46
63 limit 62 to (childhood <birth to 12 years> or adolescence <13 to 17 years>)
64 5 and 46 and 61
65 63 or 64
66 limit 65 to yr="1987 -Current"

LILACS - Latin American and Caribbean Health Sciences

A. MH Obsessive-Compulsive Disorder OR MH ocd OR TW obsess$ OR Tw compulsi$
B. MH Telemedicine OR MH Electronic Mail OR MH Telephone OR MH Videoconferencing OR MH Internet OR MH Computers OR MH Software OR MH Decision Making, Computer-Assisted OR TW smartphone$ OR

TW telephone$ OR TW computer$ OR TW distance$ OR TW remote OR TW internet$ OR TW telepsychiatry OR TW telepsychology OR TW telemental OR TW telehealth OR TW teletherapy OR TW cybercounseling OR TW web AND TW based OR TW phone$ OR TW mobile$ OR TW e AND TW mail$ OR TW email$ OR TW electronic TW mail$ OR TW online OR TW on AND TW line OR TW videoconferenc$ OR TW video AND TW conferenc$ OR TW chat AND TW room$ OR TW instant AND TW messaging OR TW iCBT OR TW iCBTs OR TW social AND TW media$

C. MH Child OR MH Adolescent OR TW child$ OR TW teen$ OR TW young AND TW people$ OR TW young AND TW person$ OR TW girl$ OR TW boy$ OR TW minor$ OR TW kid$ OR TW juvenile$ OR TW youth OR TW adolesc$ OR TW pediatri$ OR TW paediatri$
D. #1 AND #2 AND #3

CINAHL

S53 S5 AND S35 AND S51 Limiters - Published Date: 19870101-20171231
Search modes - Boolean/Phrase
S52 S5 AND S35 AND S51
S51 S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50
S50 TI p#ediatri* OR AB p#ediatri*
S49 TI adolesc* OR AB adolesc*
S48 TI youth OR AB youth
S47 TI juvenile* OR AB juvenile*
S46 TI teen* OR AB teen*
S45 TI kid* OR AB kid*
S44 TI minor* OR AB minor*
S43 TI boy* OR AB boy*
S42 TI girl* OR AB girl*
S41 TI (young N2 person*) OR AB (young N2 person*)
S40 TI (young N2 people*) OR AB (young N2 people*)
S39 TI teen* OR AB teen*

S38 TI child* OR AB child*
S37 (MH "Adolescence+")
S36 (MH "Child+")
S35 S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34
S34 TI "social media?" OR AB "social media?"
S33 TI iCBTs OR AB iCBTs
S32 TI iCBT OR AB iCBT
S31 TI (instant Nj2 messaging) OR AB (instant N2 messaging)
S30 TI (chat N2 room*) OR AB (chat N2 room*)
S29 TI "video conferenc*" OR AB "video conferenc*"
S28 TI videoconferenc* OR AB videoconferenc*
S27 TI "on line" OR AB "on line"
S26 TI online OR AB online
S25 TI "electronic mail*" OR AB "electronic mail*"
S24 TI email* OR AB email*
S23 TI "e mail* OR AB "e mail*
S22 TI mobile* OR AB mobile*
S21 TI phone* OR AB phone*
S20 TI (web N2 based) OR AB (web N2 based)
S19 TI cybercounseling OR AB cybercounseling
S18 TI teletherapy OR AB teletherapy
S17 TI telehealth OR AB telehealth
S16 TI telemental OR AB telemental
S15 TI telepsychology OR AB telepsychology
S14 TI telepsychiatry OR AB telepsychiatry
S13 TI internet* OR AB internet*
S12 TI remote OR AB remote
S11 TI distance* OR AB distance*
S10 TI computer* OR AB computer*
S9 TI telephone* OR AB telephone*
S8 TI smartphone* OR AB smartphone*
S7 (MH "Telecommunications+")
S6 (MH "Computers and Computerization+")
S5 S1 OR S2 OR S3 OR S4
S4 TI compulsi* OR AB compulsi*
S3 TI obsess* OR AB obsess*
S2 TI ocd OR AB ocd
S1 (MH "Obsessive-Compulsive Disorder+")

Scopus

((TITLE-ABS-KEY (ocd)) OR (TITLE-ABS-KEY (obsess*)) OR (TITLE-ABS-KEY (compulsi*))) AND ((TITLE-ABS-

KEY (smartphone*)) OR (TITLE-ABS-KEY (telephone*)) OR (TITLE-ABS-KEY (computer*)) OR (TITLE-ABS-KEY (distance*)) OR (TITLE-ABS-KEY (remote)) OR (TITLE-ABS-KEY (internet*)) OR (TITLE-ABS-KEY (telepsychiatry)) OR (TITLE-ABS-KEY (telepsychology)) OR (TITLE-ABS-KEY (telemental)) OR (TITLE-ABS-KEY (telehealth)) OR (TITLE-ABS-KEY (teletherapy)) OR (TITLE-ABS-KEY (cybercounseling)) OR (TITLE-ABS-KEY ((web) PRE/2 (based))) OR (TITLE-ABS-KEY (phone*)) OR (TITLE-ABS-KEY (phone*)) OR (TITLE-ABS-KEY (mobile*)) OR (TITLE-ABS-KEY ("e mail*")) OR (TITLE-ABS-KEY (email*)) OR (TITLE-ABS-KEY ("electronic mail*")) OR (TITLE-ABS-KEY (online)) OR (TITLE-ABS-KEY ("on line")) OR (TITLE-ABS-KEY (videoconferenc*)) OR (TITLE-ABS-KEY ("video conferenc*")) OR (TITLE-ABS-KEY ((chat) PRE/2 (room*))) OR (TITLE-ABS-KEY ((instant) PRE/2 (messaging))) OR (TITLE-ABS-KEY (icbt)) OR (TITLE-ABS-KEY (icbts)) OR (TITLE-ABS-KEY ("social media")) OR (TITLE-ABS-KEY ("social medias"))) AND ((TITLE-ABS-KEY (child*)) OR (TITLE-ABS-KEY (teen*)) OR (TITLE-ABS-KEY ((young) W/2 (people*))) (TITLE-ABS-KEY ((young) W/2 (person*))) OR (TITLE-ABS-KEY (girl*)) OR (TITLE-ABS-KEY (boy*)) OR (TITLE-ABS-KEY (minor*)) OR (TITLE-ABS-KEY (kid*)) OR (TITLE-ABS-KEY (juvenile*)) OR (TITLE-ABS-KEY (youth)) OR (TITLE-ABS-KEY (adolesc*)) OR (TITLE-ABS-KEY (pediatri*)) OR (TITLE-ABS-KEY (paediatri*))) AND (LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2007) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2002) OR LIMIT-TO (PUBYEAR , 2001) OR LIMIT-TO (PUBYEAR , 2000) OR LIMIT-TO (PUBYEAR , 1999) OR LIMIT-TO (PUBYEAR , 1998) OR LIMIT-TO (PUBYEAR , 1997) OR LIMIT-TO (PUBYEAR , 1996) OR LIMIT-TO (PUBYEAR , 1994) OR LIMIT-TO (PUBYEAR , 1993) OR LIMIT-TO (PUBYEAR , 1992) OR LIMIT-TO (PUBYEAR , 1991) OR LIMIT-TO (PUBYEAR , 1989) OR LIMIT-TO (PUBYEAR , 1988) OR LIMIT-TO (PUBYEAR , 1987))

WHO International Clinical Trials Registry Platform

Title: smartphone* OR telephone* OR computer* OR distance OR remote OR internet* OR telepsychiatry OR telepsychology OR telemental OR telehealth OR teletherapy OR cybercounseling OR "web based" OR phone* OR mobile* OR "e mail" OR email OR "electronic mail" OR oneline OR "on line" OR videoconference OR "video conference" OR "chat room" OR "chat rooms" OR "instant messaging" OR ICBT OR ICBTs OR "social media"

AND
Condition: ocd OR obsess* OR compulsi*

ClinicalTrial.gov
Condition/Disease: ocd OR obsess* OR compulsi*
Other Terms: smartphone* OR telephone* OR computer* OR distance OR remote OR internet* OR telepsychiatry OR telepsychology OR telemental OR telehealth OR teletherapy OR cybercounseling OR "web based" OR phone* OR mobile* OR "e mail" OR email OR "electronic mail" OR oneline OR "on line" OR videoconference OR "video conference" OR "chat room" OR "chat rooms" OR "instant messaging" OR ICBT OR ICBTs OR "social media"

7.2. Systematic review: Prisma checklist

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	#1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	#1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	#2-#3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	#4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	#4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	#4-#6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	#4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Protocol, #4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	#7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	#4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Protocol, #4
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Protocol, #4
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Table 2
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	NA

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	#11
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	#7 Flow Diagram
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	#7-#9 Table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Table 4
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	#9-#11 Table 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	#11 Table 4
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	#12-#14
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	#14
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	#16
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	#1

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

7.3. Systematic review: Overview of assessment instruments

Additional File. Overview of assessment instruments

Abbreviation	Full Name	Study	Purpose	Respondent	Interpretation
ADIS (CSR)	The Anxiety Disorders Interview Schedule	Comer et al. 2014, Comer et al. 2017	Assesses child psychopathology in accordance to DSM–IV	Self-Assessment & Parents	Scores 0 – 8, with a score of 4 or higher indicating a clinically significant diagnosis
CDI	Children's Depression Inventory	Farrell et al. 2016	Rates severity of symptoms related to depression or dysthymic disorder in a pediatric sample	Self-Assessment	Scores range between 0-54 19–20 is generally accepted as depression 36 or higher relatively severe depression
CGAS	The Children's Global Assessment Scale	Lenhard et al. 2017 and Lenhard et al. 2014	Rates the general functioning of patients under the age of 18	Clinician	10–1 Needs constant supervision 20–11 Needs considerable supervision 30–21 Unable to function in almost all areas 40–31 Major impairment of functioning in several areas 50–41 Moderate degree of interference in functioning in most social areas or severe impairment of functioning in one area 60–51 Variable functioning with sporadic difficulties or symptoms in several but not all social areas 70–61 Some difficulty in a single area but generally functioning well 80–71 No more than slight impairments in functioning at home, at school, or with peers; some disturbance of behavior or emotional distress may be present in response to life stresses 90–81 Good functioning in all areas 100–91 Superior functioning in all areas
CGI	The Clinical Global Impression	All	Measures symptom severity and treatment response in patients with mental disorders	Clinician	Severity Scale: 1 -Normal, not at all ill 2 -Borderline mentally ill 3- Mildly ill 4- Moderately ill 5- Markedly ill 6- Severely ill 7- Among the most extremely ill patients Improvement Scale: 1 -Very much improved 2 -Much improved 3 -Minimally improved 4 -No change 5 -Minimally worse 6 -Much worse 7 -Very much worse
ChOCI-R (symptom/impairment Parent) (symptom/impairment Child)	Children's Obsessional Compulsive Inventory-Revised	Lenhard et al. 2017 and Lenhard et al. 2014	Assesses the content and impairment of compulsions and obsessions in children and adolescents aged 7-17 years	Self-Assessment & Parents	32-item, two-part measure assessing the content and severity of compulsions and obsessions in children and adolescents aged 7-17 years. It provides a raw score for compulsion and obsession, and also a raw score for total impairment from 0 to 48 and total symptoms from 0 to 40. Total impairment score of >17
COIS Child/Parent	Child OCD Impact Scale	Storch et al. 2011 and Lenhard et al. 2014	Assesses the impact of OCD symptoms on psychosocial functioning in children and adolescents	Self-Assessment & Parents	4-point Likert-scale: 0 -Not at all 1-Just a Little 2-Pretty Much 3-Very Much Maximum possible score of 99, with higher scores indicating more impairment.
CSQ-8	The Client Satisfaction Questionnaire	Comer et al. 2014 and Comer et al. 2017	Assesses client satisfaction with health, human services, governmental and public benefit programs and services	Self-Assessment & Parents	Scores range from 8 to 32, with higher values indicating higher satisfaction.
CY-BOCS Child/Parent	The Children's Yale-Brown Obsessive-Compulsive Scale	All	Rates the severity of OCD symptoms	Clinician	0–7 subclinical 8–15 mild 16–23 moderate 24–31 severe 32–40 extreme

EWSAS Child / Parent	Education, Work and Social Adjustment Scale	Lenhard et al. 2017	This assessment is an adaptation of the Work and Social Adjustment Scale for children and adolescents and rates the degree of impairment of the patient	Self-Assessment	Tests 5 different areas of functioning (school, everyday situations, social activities, leisure time, family and relationships). Higher ratings indicating more impairment, scores range from 0 to 40.
FAS	Family Accommodation Scale	Comer et al. 2014 and Comer et al. 2017	Assesses the family's accommodation to the child's OCD symptoms during the previous month	Parents	5-point Likert-scale ranging from 0 to 76, with higher scores indicating more accommodation. 0 -Never 1 = Once a week 2 = 2-3 times a week 3 = 4-6 times a week 4 = Every day
MASC	Multidimensional Anxiety Scale for Children	Farrell et al. 2016	Assesses the presence of symptoms related to anxiety disorders in children and youth ages 8 to 19 years	Self-Assessment & Parents	4-point Likert-scale: 0-Never true about me 1-Rarely true about me 2-Sometimes true about me 3-Often true about me Maximum possible score of 117, higher scores indicating more symptoms.
NIMH GOCS	National Institute of Mental Health Global Obsessive-Compulsive Scale	Farrell et al. 2016	Rates the severity of obsessive-compulsive disorder symptoms on a scale from 1 (minimal symptoms) to 15 (very severe)	Clinician	A scale from 1 (minimal symptoms) to 15 (very severe)
PWA	Parent Working Alliance	Storch et al. 2011	Rates parent satisfaction with services	Parents	5-point Likert scale: 0 = very false/very dissatisfied to 4 = very true/very satisfied Total score ranges from 0–20, with higher scores indicating stronger alliance.
PedsQL	Pediatric Quality of Life Scale	Farrell et al. 2016	Measures health related quality of life in healthy children and adolescents and those with acute and chronic health conditions	Self-Assessment & Parents	Higher scores indicate better health-related quality of life. Scores range from 0 to 92
SCAS-S	Spence Child Anxiety Scale short version for children/ parents	Lenhard et al. 2017 Lenhard et al. 2014	Assesses anxiety symptoms in children	Self-Assessment & Parents	4-point Likert-scale. Never = 0 Sometimes = 1 Often = 2 Always = 3 Maximum possible score of 132, higher scores indicating more symptoms.
SDQ	Strength and Difficulties Questionnaire	Lenhard et al. 2014	A brief behavioral screening questionnaire	Self-Assessment & Parents	Total difficulty score ranges from 0 to 40, with higher scores indicating more issues on: 1) emotional symptoms (5 items) 2) conduct problems (5 items) 3) hyperactivity/inattention (5 items) 4) peer relationship problems (5 items) 5) prosocial behaviour (5 items)
WAI	Working Alliance Inventory	Comer et al. 2017	Non-standardised assessment on therapist working alliance	Self-Assessment	8-point Likert scale. Total scores range from 36 to 252. Higher scores reflect more positive ratings of Working Alliance.

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