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Review

Internet-delivered cognitive behavior therapy for children and adolescents: A systematic review and meta-analysis

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HIGHLIGHTS

- A systematic review of internet-delivered CBT for youth was conducted.
- Twenty-five studies, targeting 11 different disorders, were found.
- Quality ratings and ICBT characteristics varied largely across the studies.
- ICBT yielded moderate effect sizes compared to waitlist control.
- Results indicate that ICBT could be an effective treatment format for children.

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ABSTRACT

Internet-delivered cognitive behavior therapy (ICBT) is a relatively novel treatment format with the potential to increase accessibility of evidence-based care. However, little is known about the feasibility and efficacy of ICBT in children and adolescents. We conducted a comprehensive systematic review and meta-analysis of ICBT for children and adolescents to provide an overview of the field and assess the efficacy of these interventions. A systematic literature search of six electronic databases was performed to identify ICBT intervention studies for children with a psychiatric condition, such as social anxiety disorder, or a somatic condition, such as chronic pain. Two reviewers independently rated study quality. Twenty-five studies, targeting 11 different disorders, were included in the review. Study quality and presentation of treatment variables, such as therapist time and treatment adherence, varied largely. Twenty-four studies ($N = 1882$) were included in the meta-analysis and ICBT yielded moderate between-group effect sizes when compared with waitlist, $g = 0.62$, 95% CI [0.41, 0.84]. The results suggest that CBT for psychiatric and somatic conditions in children and adolescents can be successfully adapted to an internet-delivered format.

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1. Introduction

Cognitive behavior therapy (CBT) has been proven effective for a variety of psychiatric and somatic conditions in children such as anxiety disorders, obsessive-compulsive disorder (OCD) (Reynolds, Wilson, Austin, & Hooper, 2012) and chronic pain (Eccleston et al., 2014). CBT has shown promising effects for depression (David-Ferdon & Kaslow, 2008), and is also being investigated as a main or additional treatment in an increasing number of somatic conditions like obesity, asthma and diabetes (Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012). Most of the disorders for which CBT has shown effect are associated with great suffering and the problems often persist into adulthood (Horst et al., 2014; Kendall, Safford, Flannery-Schroeder, & Webb, 2004). Only a small proportion of children and adolescents with these disorders receive any form of psychological treatment (Chavira, Stein, Bailey, & Stein, 2004; Costello, He, Sampson, Kessler, & Merikangas, 2014), and probably even fewer receive evidence-based treatments (Kazdin & Nock, 2003; Shafran et al., 2009). To make evidence-based psychological treatments of psychiatric and somatic disorders available on a broader scale, it is essential to develop effective ways of treatment delivery.

Internet-delivered CBT (ICBT) has been developed through the integration of information technology and psychological treatment. ICBT can be described as a therapist-guided self-help intervention (Andersson, 2009) where the treatment content is delivered through a website in form of written texts, audio files and/or videos. Typically, participants get access to the treatment modules consecutively during a pre-specified time frame. Therapist support, if included, can be provided through written online messages or, in some cases, phone calls (Andersson, 2009).

ICBT carries several advantages compared to traditional psychological treatments: it requires less therapist time per patient, in adult ICBT approximately 85% less therapist time per week (Hedman, Ljótsson, & Lindfors, 2012), and is not limited to office hours. It can be delivered regardless of geographical distances between therapist and patient, can reduce the potential risk of stigma involved in visiting a therapist, and children and their parents can engage in the treatment without missing school or work (Marks, Cavanagh, & Gega, 2007). As the internet-delivered programs are standardized, the risk for therapist drift, a common phenomenon in face-to-face treatments (Waller, 2009), is reduced. ICBT has rapidly emerged as an evidence-based alternative in adult populations. In a review of 108 randomized controlled studies, ICBT was found to be effective for psychiatric (e.g., social anxiety disorder, panic disorder, OCD) as well as somatic (e.g., chronic pain, irritable bowel

syndrome) disorders in adults and also appears to be a cost-effective alternative to traditional CBT for some disorders (Hedman et al., 2012). In addition, a recent meta-analysis found that ICBT for adults may be as effective as face-to-face CBT for common psychiatric disorders (Andersson, Cuijpers, Carlbring, Riper, & Hedman, 2014). Overall, there is much to indicate that ICBT could be an effective and reliable tool to increase availability to evidence-based psychological treatments for children and adolescents.

However, even though there is substantial evidence for ICBT in adult patient populations, the generalizability of those results to children and adolescents is limited due to important developmental and practical differences. For example, intervention content, texts and exercises for children need to be tailored with respect to reading level, cognitive ability, motivation and involvement of the parents in the treatment. Even though the number of studies on ICBT for children and adolescents is increasing (Fisher, Law, Palermo, & Eccleston, 2015; Richardson, Stallard, & Velleman, 2010; Ye et al., 2014), the evidence base is still very limited compared to the substantial amount of studies of ICBT in adult populations. A review and meta-analysis on ICBT for anxiety in children included seven studies and found a moderate effect ($d = 0.69$) on anxiety reduction (Rooksby, Elouafkaoui, Humphris, Clarkson, & Freeman, 2015), which is comparable to the effects reported in face-to-face CBT (James, James, Cowdrey, Soler, & Choke, 2013). A recent Cochrane review on remotely-delivered psychological therapies for pediatric chronic or recurrent pain included eight studies, and found a significant reduction in pain-severity ($d = 0.61$) in headache and mixed pain conditions at post-treatment (Fisher et al., 2015).

Earlier reviews on internet-delivered or computerized child interventions have often included all forms of computerized therapy, including interventions delivered via for example CD-ROM and web-camera (Fisher et al., 2015; Richardson et al., 2010; Rooksby et al., 2015). However, CD-ROM is an outmoded medium that does not include therapist contact and gives no information on how much of the treatment the participant actually took part of. Treatments using web-camera sessions require appointments between therapist and patient and do therefore not provide the same time- and cost-saving possibilities as ICBT. Because ICBT is a markedly different method of delivery and holds important advantages over other computerized interventions, its effects should be investigated separately. To the best of our knowledge, no earlier review has targeted ICBT for childhood patient populations without restriction to diagnostic type and therefore there is a need to identify areas in which ICBT has been tested and found efficacious as well as to understand future directions for this novel approach.

Our objective was to perform a comprehensive, systematic review of the literature in the field of ICBT for children and adolescents. Specifically, we aimed to investigate for which childhood psychiatric and somatic conditions ICBT has been tested. To be able to describe the state of the field accurately, we included not only randomized controlled trials but also trials without randomization or control conditions. Furthermore, we explored study characteristics such as duration and intensity of the intervention, therapist support, treatment adherence, study design and study quality. Finally, we aimed to investigate the efficacy of those interventions in a meta-analysis, and to perform a meta-regression analysis to explore whether any study characteristics were associated with treatment outcomes.

2. Methods

2.1. Data sources and search strategy

Two searches were conducted using the databases Medline, PsycInfo, Cinahl, Scopus, Web of Science, and Cochrane. The first searched for articles published until March 2015, and the second search was to update for articles published until March 2016. The search strategy employed a combination of search terms including Internet (or online, web, e-health, computer) and CBT (or behavior, cognitive, therapy, treatment) and was limited to an age range from 0 to 18 years. The complete search strings can be viewed in Supplement 1.

2.2. Study selection

Articles were included if a) the investigated treatment was defined as ICBT, b) ICBT was the main treatment component (i.e. not a complement to face-to-face CBT), c) the ICBT focused on symptom reduction of an identified psychiatric or somatic condition or a well-defined psychiatric or somatic problem (e.g. symptom severity levels above a clinically relevant cut-off), d) participant age was 0–18 years (studies with participants over 18 years had to have a mean participant age under 18), e) data were analyzed on a group level (i.e. case studies were not included), f) outcome data on a continuous outcome symptom measure that allowed for calculation of within- or between-group effect sizes were reported, g) the study was published in peer-reviewed journals, published peer-reviewed conference papers or in a master or PhD thesis. In addition, h) if the investigated ICBT primarily targeted parents the aim of the treatment had to be to alleviate the child's symptoms.

An intervention was categorized as CBT based on either (1) the authors of the original article stated explicitly that the intervention was CBT and the authors of this review found no reason to disagree, based on how the components of the intervention was described in the article, or (2) no statement in the original article about the intervention being CBT was made, but from the description of the components in the treatment a joint decision of the assessing authors was taken if this was to be regarded as CBT, and (3) if any uncertainty still remained the original authors were contacted through e-mail and asked whether they would describe their intervention as CBT or not.

Each article was independently assessed by two of the four co-authors SV, FL, MB and ML in a stepwise manner at title, abstract and full text level to evaluate inclusion or exclusion according to the criteria presented above. If complete agreement of exclusion was not reached, articles were assessed at the next level. Uncertainties regarding inclusion at the full text level were discussed until consensus within pairs was reached.

2.3. Data extraction

The following variables were extracted from the included studies for further analysis: study sample size, participant age, study design, control condition or comparator (categorized as passive control or wait list, active control or face-to-face treatment), diagnostic type

(categorized as “Psychiatric” or “Somatic”) and outcome measure. The primary outcome measure was chosen if it was a measure of symptom reduction of the targeted disorder. If not, the outcome measure that met that criteria was chosen based on the literature in the field (e.g. pain intensity for chronic pain). Type of outcome informant was categorized as “clinician-rated”, “self-rated”, “parent-rated” or a “physiological measure” (e.g. BMI). Pre- and post-treatment means and standard deviations of outcome measures at pre- and post-treatment were extracted for meta-analytical calculations.

2.4. Assessment of study quality

All included studies were assessed with the quality assessment instrument developed by Moncrieff et al. (Moncrieff, Churchill, Drummond, & McGuire, 2001), a scale measuring study quality on 23 different characteristics, each evaluated on a 3-point scale (0 = poor, 1 = fair, 2 = good), including ratings on appropriate sample size, study design, statistical analyses and presentation of results. In the original article the mean ratings of 30 mental health trials were between 16.3 ($SD = 6.3$) and 20.9 ($SD = 9.0$) and the inter-rater reliability was in the excellent range ($r = 0.75$ to 0.86) (Moncrieff et al., 2001).

Each article was independently assessed by two of the four co-authors SV, FL, MB and ML and discrepancies was solved by consensus decision. Four of the included studies were written by coauthors of this review (Bonnert et al., 2014; Lenhard et al., 2014; Vigerland et al., 2013; Vigerland et al., 2016). None of the authors were involved in the rating of their own paper.

2.5. Statistical analysis

A random effects meta-analysis was conducted using the chosen outcome in the respective studies, see Table 1. The within-group and between-group effect sizes and their variances were calculated as Hedge's g , i.e., the mean difference divided by the pooled standard deviation, corrected for sample size (using formulas in Borenstein, Hedges, Higgins, & Rothstein, 2009). Within-group effects were calculated based on the pre- and post-treatment assessments for groups receiving ICBT. Pooled within-group effects were calculated for all included studies and separately for the studies of psychiatric and somatic conditions. Between-group effect sizes were calculated using post-treatment scores on the chosen outcome in the ICBT treatment group in comparison to wait-list, active control or face-to-face treatment conditions. Heterogeneity between studies was assessed with I^2 , which is the proportion of variance across due to true heterogeneity (Higgins & Thompson, 2002; Higgins, Thompson, Deeks, & Altman, 2003) and Cochran's Q , which tests the statistical significance of the heterogeneity (Cochran, 1954). Funnel plots (Light & Pillemer, 1984) and regression tests (Egger, Davey Smith, Schneider, & Minder, 1997) were made to assess publication bias in the studies of psychiatric and somatic diagnoses.

We conducted an exploratory meta-regression analysis to investigate moderators of treatment effect and possible causes of heterogeneity. The following variables were included in a series of meta-regressions: study quality, type of informant, sample size, treatment duration, and age. All statistical analyses were conducted in R (R Core Team, 2015) using the metafor package (Viechtbauer, 2010).

3. Results

3.1. Systematic review

3.1.1. Included studies

The database search resulted in 5258 articles, of which 27 fulfilled all inclusion criteria (see Fig. 1). Two of these (Högström, Enebrink, Melin, & Ghaderi, 2015; Nijhof et al., 2013) were long-term follow-ups of other included studies (Enebrink, Högström, Forster, & Ghaderi, 2012; Nijhof, Bleijenberg, Uiterwaal, Kimpen, & van de Putte, 2012) and are not

Table 1
Overview of included studies.

Study no.	First author	Year published	Target disorder	Age interval (years)	Sample size	Study design	Primary outcome & measure	Outcome informant	Study quality (Moncreiff)
1	Bonnert	2014	Functional gastrointestinal disorders	13–17	29	Open trial	GSRS-IBS Gastrointestinal symptoms	Self-rated	29
2	de Bruin	2014	Insomnia	13–19	27	Quasi-random design	Actigraphy Sleep efficiency	Physiological measure	21
3	de Bruin	2015	Insomnia	12–19	116	RCT	Actigraphy Sleep efficiency	Physiological measure	34
4	Donovan	2014	Anxiety disorders	3–6	52	RCT	CSR (based on parent interview) Severity of anxiety	Clinician-rated	35
5	Doyle	2008	Overweight and eating disorder symptoms	12–17	83	RCT	BMI Weight	Physiological measure	30
6	Enebrink	2012	Conduct problems	3–12	104	RCT	ECBI Perceived intensity of child disruptive behaviors	Parent-rated	35
7	Hicks	2006	Recurrent pain (abdominal pain or headache)	9–16	47	RCT	Pain diary Frequency	Self-rated	25
8	Jones	2008	Overweight and binge eating	12–19	105	RCT	BMI Weight	Self-rated	30
9	Joseph	2013	Asthma	14–18	422	RCT	Days with asthma symptoms	Self-rated	29
10	Law	2015	Chronic headache	11–17	83	RCT	Headache diary Frequency	Self-rated	32
11	Lenhard	2014	Obsessive compulsive disorder	12–17	21	Open trial	CY-BOCS Obsessive and compulsive symptoms	Clinician-rated	31
12	Makarushka	2011	Depressed mood	11–15	239	RCT	CES-D Depressive symptoms	Self-rated	29
13	March	2009	Anxiety disorders	7–12	73	RCT	CSR Severity of anxiety	Clinician-rated	35
14	Nijhof	2012	Chronic fatigue	12–18	135	RCT	CIS-20 Fatigue severity	Self-rated	38
15	Palermo	2009	Chronic pain	11–17	48	RCT	Pain intensity on-line diary	Self-rated	33
16	Palermo	2016	Chronic pain	11–17	273	RCT	Pain intensity on-line diary	Self-rated	37
17	Ritterband	2003	Encopresis	6–12	24	RCT	Defecation accidents per week	Parent-rated	17
18	Silfvnarnagel	2015	Anxiety disorders	15–19	11	Open trial	BAI Anxiety symptoms	Self-rated	23
19	Spence	2011	Anxiety disorders	12–18	115	RCT	CSR Severity of anxiety	Clinician-rated	37
20	Tillfors	2011	Social anxiety disorder	15–21	19	RCT	LSAS-SR Anxiety symptoms	Self-rated	28
21	Trautmann	2008	Recurrent headache	10–18	18	RCT	Headache diary Frequency	Self-rated	16
22	Trautmann	2010	Recurrent headache	10–18	68	RCT	Headache diary Frequency	Self-rated	26
23	Vigerland	2013	Specific phobia	8–12	30	Open trial	CSR Severity of anxiety	Clinician-rated	31
24	Vigerland	2016	Anxiety disorders	8–12	93	RCT	CSR Severity of anxiety	Clinician-rated	34
25	Voerman	2015	Chronic pain	12–17	69	Open trial	Pain diary Intensity	Self-rated	20

Abbreviations: BAI = Beck Anxiety Inventory; BMI = Body Mass Index; CES-D = Center for Epidemiological Studies-Depression; CIS-20 = Checklist Individual Strength-20; CSR = Clinician severity rating (derived from the Anxiety Disorders Interview Schedule Child and Parent Version); CY-BOCS = Children's Yale-Brown Obsessive Compulsive Scale; ECBI = Eyberg Child Behavior Inventory; GSRS-IBS = Gastrointestinal Symptom Rating Scale for Irritable Bowel Syndrome; LSAS-SR = Liebowitz Social Anxiety Scale Self-Report; RCT = randomized controlled trial;

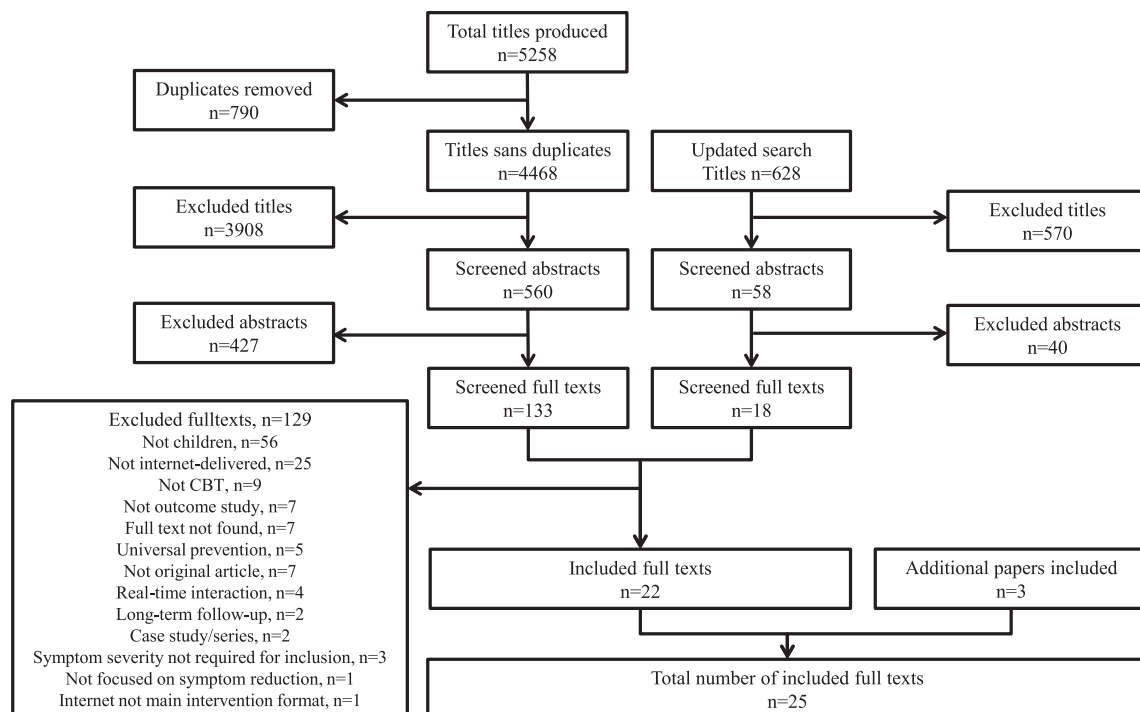


Fig. 1. Flow chart.

reported separately. One study (Joseph et al., 2013), reported follow-up assessments but lacked data on assessments immediately after treatment and was therefore not analyzed in the meta-analysis. Thus, 25 studies were included in the systematic review and 24 in the meta-analyses ($n = 1882$). Below, studies are referred to according to the numbering in Table 1.

Nineteen of the studies were randomized controlled trials, two were quasi-randomized controlled trials and four were uncontrolled open trials. Sample sizes ranged from 11 to 422 ($M = 88.8$, $Mdn = 69$). With the largest study removed, sample sizes ranged from 11 to 273 ($M = 74.9$, $Mdn = 67$). Age interval in the sample was 3–21 years. Targeted psychiatric and somatic conditions, as defined in the studies, were mixed anxiety disorders, asthma, chronic fatigue, chronic and recurrent pain, conduct problems, depressed mood, encopresis, functional gastrointestinal disorders, insomnia, obsessive compulsive disorder and overweight. Regarding diagnostic type, 11 studies were categorized as targeting psychiatric conditions and 14 studies were categorized as targeting somatic conditions.

3.1.2. Duration and intensity

ICBT interventions included between 4 and 30 treatment modules ($M = 9.9$, $Mdn = 8$) that were to be completed over a period of 3 to 26 weeks ($M = 10.2$, $Mdn = 8$). Fifteen interventions seemed to offer a “once a week” format with approximately the same number of treatment modules and treatment weeks. Ten interventions had either more weeks than modules (studies 1, 6, 9, 14, 15 and 18), or more modules than weeks (studies 13, 17, 23 and 24), and two studies allowed a flexible treatment duration (studies 9 and 18). Two studies (studies 4 and 13) included booster sessions one and three months after treatment. Study 21 and 22 included booster emails one and two months after treatment and study 9 included a booster message at 6-month follow-up.

3.1.3. Therapist support

Twenty-one of interventions on the 25 studies included therapist support. Support was provided through written messages only (studies 2, 3, 6, 10, 14, 15, 16, 20, 21, 22), or a combination of written messages and telephone calls (studies 1, 4, 5, 7, 13, 18, 19, 23, 24, 25). One study offered face-to-face support to a subset of participants (8). Thirteen studies (2, 3, 4, 6, 7, 10, 11, 13, 15, 16, 19, 21, 22) reported therapist time, and the time ranged from a total of 60 to 240 min per participant. One of the studies (study 6) clearly specified therapist time in terms of time for registration of new participants on the internet treatment homepage, time for conducting a diagnostic interview before entering the study and time spent on communication via text messages in the platform. For the remaining studies, no such specification was reported.

3.1.4. Parental involvement

Fifteen studies had separate parent-directed modules (studies 1, 4, 6, 7, 8, 10, 11, 13, 14, 15, 16, 19, 23, 24, 25) and two studies directed the interventions only to parents (studies 4 and 6). Study 17 had modules completed by parents and children together. Remaining studies, with no separate parent-directed modules, were directed at children older than 10 years.

3.1.5. Treatment adherence

Treatment adherence was not consistently reported. Five studies reported percentage of participants completing all modules (studies 2, 3, 9, 14 and 25), five studies reported the percentage of participants who had completed a certain number of modules within the treatment period (studies 1, 10, 18, 23 and 24), three studies reported mean number of modules completed within the treatment period (studies 6, 11, 20), and six studies reported both average number of completed modules and proportion who completed all modules (studies 4, 12, 13, 15, 16 and 19). Six studies presented no clear definition of treatment adherence (studies 5, 7, 8, 17, 21 and 22).

3.1.6. Treatment response

Treatment response was defined and reported differently in the studies. Seven studies reported proportion of participants no longer fulfilling diagnostic criteria at post-treatment (studies 3, 4, 13, 18, 19, 23 and 24), six studies reported reliable or clinically significant change (studies 6, 7, 10, 15, 20, and 22), four studies reported recovery or remission according to a cut-off definition (studies 11, 14, 17 and 21) and eight studies did not report treatment response rates (studies 1, 2, 5, 8, 9, 12, 16, 25). Overall, treatment response rates (regardless of definition) ranged from 20 to 76%.

3.1.7. Outcome informant

Most psychiatry studies (6 out of 10) used clinician rated symptom severity as the primary outcome (studies 4, 11, 13, 19, 23 and 24) (see Table 1). In contrast, none of the studies of somatic condition applied clinician ratings. Child ratings were frequently used in studies of somatic condition (studies 1, 7, 9, 10, 15, 16, 21, 22 and 25), and less frequent in studies of psychiatric conditions (studies 12, 14, 18 and 20). Physiological measures were exclusively used in studies of somatic condition (studies 2, 3, 5 and 8). A parent rated primary outcome was used in two studies (studies 6 and 17).

3.2. Overall study quality

Included studies had a total score on the Moncreiff rating scale ranging from 16 to 38 points ($M = 30.2$, $Md = 31$). For summed rating per study, see Table 1 and for ratings per item, see Fig. 2. Twelve of 25 studies reported a power calculation with full details (studies 1, 3, 4, 5, 8, 9, 10, 11, 14, 19, 23 and 24) and twelve studies had a clearly specified primary outcome measure (studies 1, 3, 6, 7, 10, 11, 16, 18, 22, 23, 24 and 25). Three of the studies with clinically rated primary outcomes used blind assessors (studies 4, 13 and 19), but testing of blinding was not reported in any study. A minority of trials included a representative sample (for example all consecutive admissions at a clinic as opposed to volunteers; studies 8, 9, 10, 14 and 16). Fifteen of the studies presented their results from intention to treat-analyses (studies 1, 2, 3, 4, 6, 11, 12, 13, 14, 15, 16, 19, 20, 23 and 24), while most of the other studies used completer analyses. Only one trial (study 14) assessed adverse events, and no adverse events were reported in that trial. Pearson's correlation of study quality and study publication year showed that study quality had a tendency to increase over time, however that association was not statistically significant ($r = 0.36$, $p = 0.08$).

3.3. Meta-analysis

3.3.1. Within-group effects

Within-group effect sizes were estimated for the included ICBT interventions ($n = 24$; see Fig. 3). Twenty-two studies showed a significant positive effect, with a range from a small effect size ($g = 0.19$) to a very large effect size ($g = 2.20$), while two studies showed no statistically significant effect. The pooled effect size was significant and large, $g = 0.85$, 95% CI [0.63, 1.07], $p < 0.001$. Tests for heterogeneity showed significant and considerable heterogeneity, $I^2 = 93.46\%$, 95% CI [89.01, 96.89], $Q_{23} = 280.06$, $p < 0.001$. The pooled within-group effect size for studies of psychiatric conditions was $g = 1.27$, 95% CI [0.96, 1.59], $p < 0.001$, and for somatic conditions the pooled within-group effect size was $g = 0.49$, 95% CI [0.33, 0.64], $p < 0.001$. Funnel plots and regression tests did not suggest presence of publication bias in studies of psychiatric, $z = 1.72$, $p = 0.09$, or somatic, $z = 1.71$, $p = 0.09$, conditions (see figures in Supplement 2).

3.3.2. Between-groups comparisons

Between-group effect sizes are displayed in Fig. 4. When compared to waitlist alone, a sub-group analysis of the 15 randomized controlled studies using that design showed that ICBT was significantly more effective with a moderate effect size, pooled $g = 0.62$, 95% CI [0.41, 0.84],

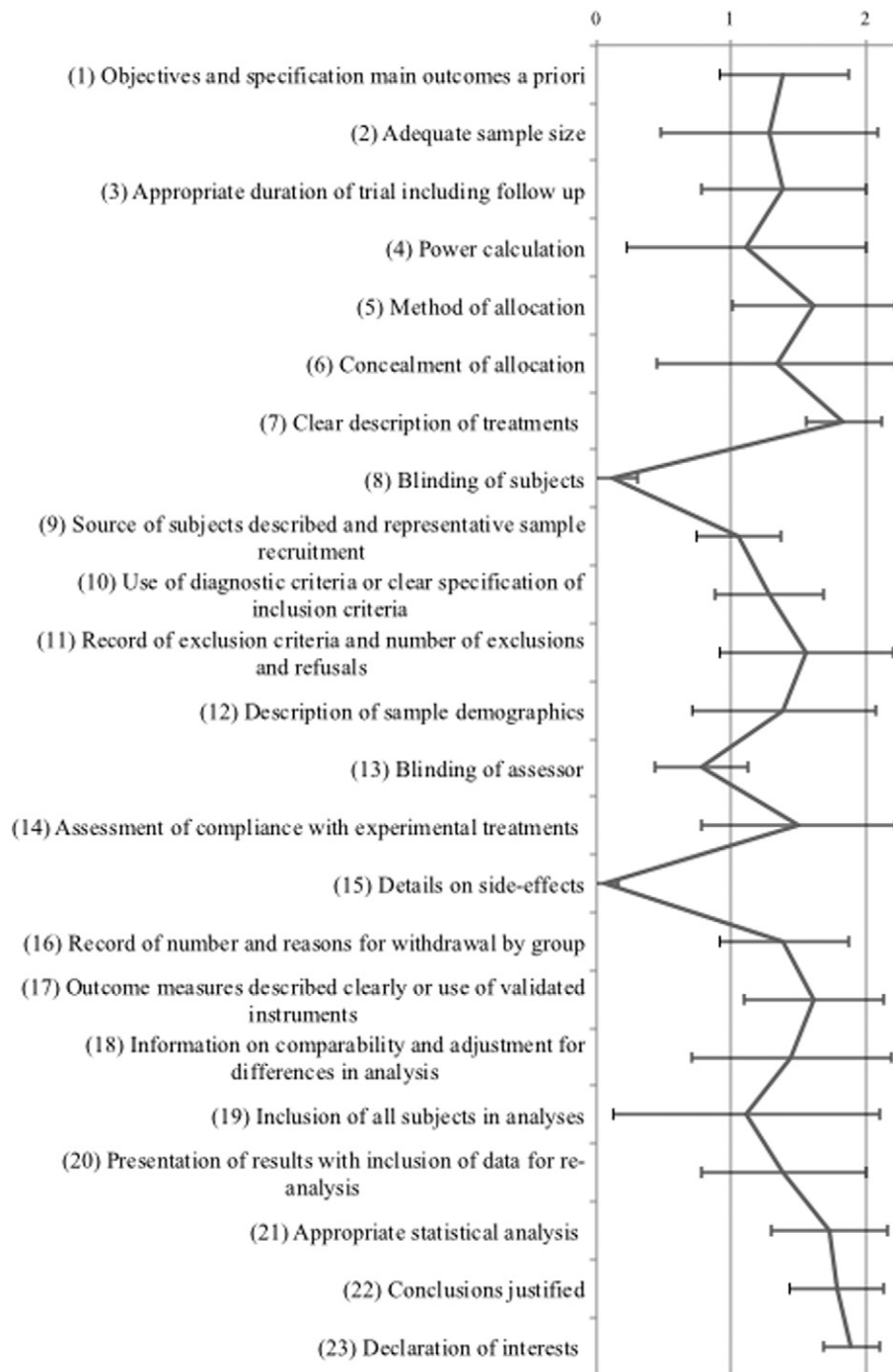


Fig. 2. Study quality ratings (means and standard deviations).

$p < 0.001$. Heterogeneity was significant and moderate, $I^2 = 65.55\%$, 95% CI [34.30, 85.86], $Q_{14} = 42.81$, $p < 0.001$.

Three studies (studies 16, 21 and 22) used active control as a comparator. A sub-group analysis of these three studies showed that ICBT was not significantly better than the active control, pooled $g = 0.10$, 95% CI [-0.32, 0.52], $p = 0.64$; heterogeneity calculation not possible. ICBT was not inferior when compared to traditional face-to-face CBT, a comparison made in three randomized studies (studies 2, 3 and 19). A sub-group analysis of these studies showed a non-significant pooled effect size, $g = 0.22$, 95% CI [-0.07, 0.50], $p = 0.14$; heterogeneity calculation not possible. Heterogeneity calculations were not possible due to the small number of samples included in the analyses.

3.4. Exploration of within-group effect size moderators

Moncrieff study quality score was not related to reported treatment effects, $p = 0.07$. Effect sizes differed significantly between studies that had different types of outcome informant with clinician ratings yielding the highest effect sizes, pooled $g = 1.39$, 95% CI [0.96, 1.82], $p < 0.001$. Outcomes based on child ratings, pooled $g = 0.75$, 95% CI [0.48, 1.02], $p < 0.001$, and physiological measures, pooled $g = 0.36$, 95% CI [-0.04, 0.76], $p = 0.08$, had significantly lower effect sizes than outcomes based on clinician ratings, $p = 0.007$ for child outcomes and $p < 0.001$ for physiological outcomes. Parent ratings and clinician ratings did not differ significantly from each other, $p = 0.15$. The residual

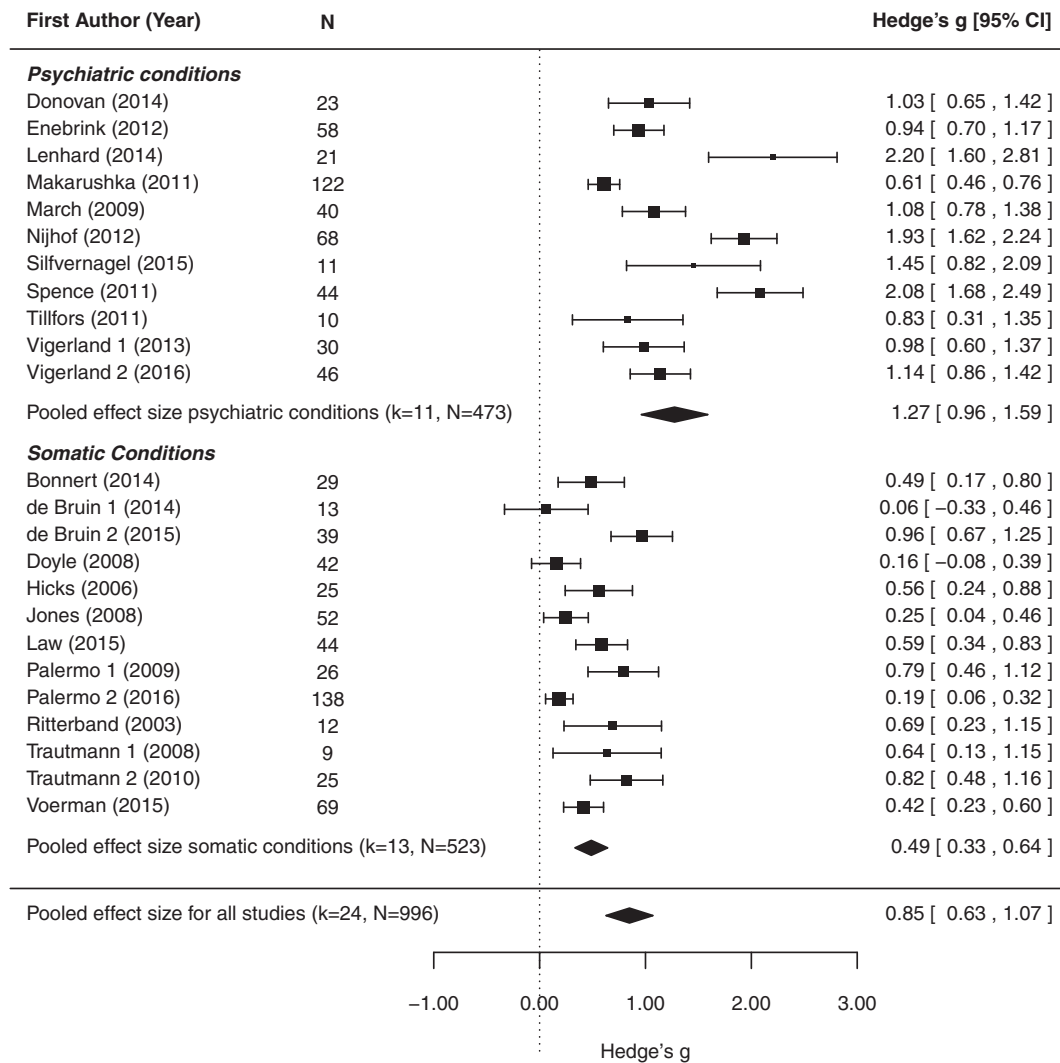


Fig. 3. Estimated and pooled within-group effect sizes.

heterogeneity after controlling for outcome informant was large, $I^2 = 90.31\%$, 95% CI [82.93, 95.64], $Q_{14} = 176.83$, $p < 0.001$.

No significant effects of sample size, $p = 0.39$, treatment duration, $p = 0.08$, or age, $p = 0.78$, were found.

4. Discussion

This is, to the best of our knowledge, the first comprehensive systematic review and meta-analysis in the novel research field of ICBT for children and adolescents with psychiatric or somatic disorders. Despite an extensive search and scrutiny of >5000 papers, only 25 studies were identified fulfilling the relatively broad inclusion criteria, indicating a field still in its infancy. The majority of these studies were randomized controlled trials. Included studies covered 11 different psychiatric and somatic conditions, with anxiety (six studies) and pain (five studies) being the most commonly targeted problems.

Ratings of study quality varied largely and some methodological limitations were common across the included studies, for example not specifying a primary outcome measure, not reporting a power calculation, not using blind assessors, only reporting results from completer analysis and not monitoring and reporting adverse events. Furthermore, a large proportion of studies used a self-referred sample. All studies included participants who fulfilled criteria for a psychiatric or somatic condition or who had symptoms above a clinically relevant cut-off, and thus our results may be relevant for clinical samples.

Considering the proposed advantages of decreased therapist time in ICBT compared to face-to-face CBT, it is unfortunate that only 13 of the 25 studies reported therapist time. Furthermore, differences in how therapist time is reported complicates comparison between studies. A standardized way of reporting therapist time would help to highlight the benefits of ICBT and enable further insight on how therapist support contributes to clinical efficacy. Meta-analyses on ICBT for adults have shown that supported interventions are associated with larger effects than unsupported interventions (Adelman, Panza, Bartley, Bontempo, & Bloch, 2014; Andersson & Cuijpers, 2009), and it is reasonable to believe that similar associations would be found in treatments for children and adolescents.

Patient adherence to ICBT was defined and reported in a number of different ways in the reviewed studies. A more unified approach to measuring and reporting adherence would facilitate comparison between the studies and may also contribute to the knowledge of how ICBT interventions could be improved. Also, assessment of parental treatment adherence could help us gain valuable insights into the role of the parent in ICBT, especially for ICBT for younger children. The majority of included studies involved parents; however, the importance of parental support and parent adherence to ICBT is currently poorly understood. Furthermore, it is possible that definitions and measures of adherence based on face-to-face treatment (such as number of completed sessions) are not suitable for ICBT, and that new measures should be developed to better reflect the specific aspects of internet-delivered treatment.

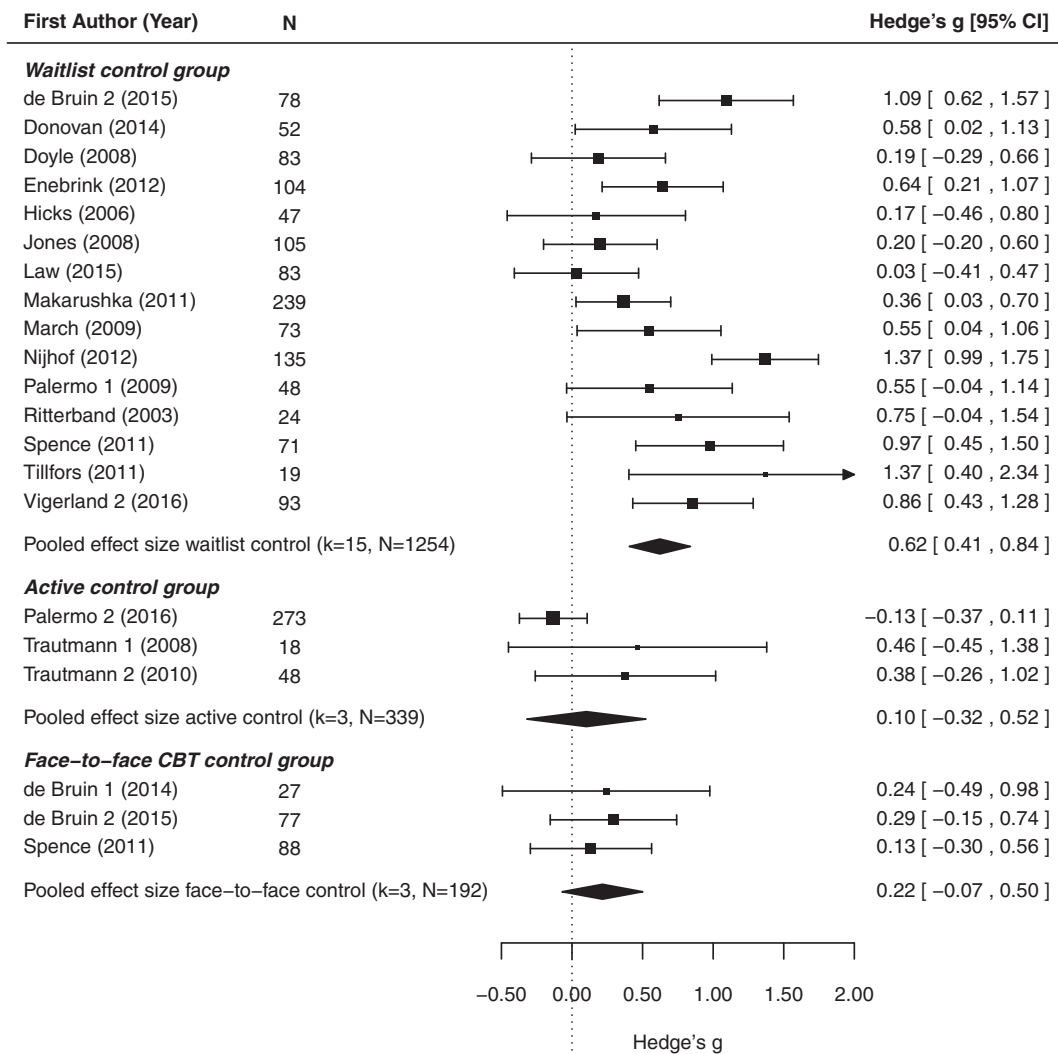


Fig. 4. Estimated and pooled between-group effect sizes.

It is apparent that the interventions in the included studies differed in a number of characteristics, for example in length, number of modules and degree of parental involvement, perhaps reflecting that optimal treatment formats will differ depending on disorder and population, and that there might not be one best way to deliver ICBT to children and adolescents across disorders. These differences may also reflect a lack of knowledge about the most optimal way to deliver ICBT to children and adolescents.

In summary, this review highlights the need for the pediatric ICBT field to report potentially advantageous variables in a more consistent and detailed way.

The meta-analysis for ICBT on within-group effect sizes showed positive effects in the large range. Tests showed a large impact of heterogeneity in the sample, therefore the pooled effect is difficult to interpret. Two studies, Doyle et al. (2008) and De Bruin, Oort, Bögels, and Meijer (2014), targeting overweight and insomnia respectively, did not show significant within-group effect-sizes. The meta-analysis also showed that ICBT yielded a moderate pooled effect when compared to waitlist control condition, which is largely consistent with meta-analyses of traditional face-to-face CBT (Hofmann et al., 2012).

Meta-analyses showed that studies of psychiatric conditions yielded large effects and studies of somatic conditions yielded moderate effects. The magnitude of effects that we found is largely comparable to those

found in traditional face-to-face CBT for chronic pain (Eccleston et al., 2014) and psychiatric disorders (McGuire et al., 2015; James et al., 2013). The difference in effects between ICBT interventions for somatic and psychiatric conditions should be interpreted cautiously as the two fields are very different regarding the nature of the clinical problems, outcome measures, and expected effect sizes. For example, symptom reduction may not be the only primary outcome of interest in studies of somatic conditions, but outcomes such as emotional or functional outcomes may be more relevant, depending on condition and treatment target.

Three studies in our review directly compared ICBT with face-to-face CBT and effects did not statistically differ between the groups (De Bruin et al., 2014; De Bruin, Bögels, Oort, & Meijer, 2015; Spence et al., 2011). This is consistent with results found in a study comparing ICBT and face-to-face CBT for adults (Andersson et al., 2014). Nevertheless, limited conclusions can be drawn from only three studies. In summary, the meta-analyses suggest that delivering ICBT over the Internet yields positive outcomes and may be a feasible way of delivering treatment across a wide range of disorders.

The meta-regression analyses could only explain some of the heterogeneity in the sample. This might be due to the wide scope of this review, as well as the limited possibility to investigate other predictors, for example therapist support, therapist time and adherence, due to lack of detail in the reports of some studies.

4.1. Limitations

Only studies of ICBT, as opposed to computerized or web camera delivered interventions were included in this review. Although it could be argued that such studies should have been included, we believe that the unique advantages of ICBT warrant separate investigation. Furthermore, this review excluded studies on for example smoking cessation and prevention of mental health problems, and the results of this study may not be generalizable to such interventions.

An important limitation of the meta-analysis included in this review is the large variation in the measures that were included, both in terms of informant type (which was clearly associated with treatment effect sizes) and domain that was measured (for example depression, anxiety, pain severity, body mass index, and sleep quality). This limitation is due to the fact that there are few studies on ICBT for children and adolescents, especially when looking at different disorders, and the large variation may have contributed to the considerable heterogeneity (I^2) in all analyses. Thus, the pooled effect sizes should be interpreted with caution and may not be meaningful representations of the overall efficacy of ICBT. More detailed conclusions will be possible when more studies are published, thus enabling researchers to conduct subgroup analyses.

4.2. Future directions

More studies on ICBT for children and adolescents with psychiatric and somatic disorders are needed to better understand the efficacy of ICBT and the factors associated with positive outcomes. Future studies on ICBT interventions should include basic quality aspects such as power calculations leading to adequate sample sizes, pre-specified primary outcomes, presentation of results from intention-to-treat analysis and clear specifications of adherence and attrition. In addition, since geographical reach and proposed cost-effectiveness are often presented as important advantages associated with ICBT, it would be beneficial for the field to systematically report such data.

4.3. Conclusions

This is the first comprehensive review and meta-analysis on ICBT in children and adolescents. We found 25 studies covering 11 different disorders, with anxiety and pain being the most commonly targeted disorder. Although ICBT is often presented as a time- and cost-effective method, key treatment variables such as therapist time or treatment adherence are insufficiently and inconsistently reported. From a methodological perspective, more high-quality studies are needed in this field. The meta-analyses showed that ICBT yields large within-group effect sizes and moderate between-group effect sizes when compared with waitlist. The results suggest that CBT could be successfully adapted to ICBT for psychiatric and somatic conditions. Thus, ICBT has the potential to increase availability of effective psychological treatments for children and adolescents on a large scale.

Declaration of interest

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