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Psychological interventions for children with chronic physical conditions: A systematic review assessing the role of emotional and cognitive processes

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Abstract

Pediatric chronic physical conditions (CPC) can lead to emotional and cognitive difficulties. Although both types of processes play a major role in child development, no systematic review in the pediatric psychology has investigated the effectiveness of interventions on these two processes concurrently. To address this gap, this review focused on the role of emotional and cognitive processes as predictors of the effectiveness of psychological interventions for children with CPC.

Studies were included if they assessed at least one emotional/cognitive process (e.g., coping/attention. We included RCTs with children (8-12 years) with a CPC (e.g., diabetes, asthma), which implemented a psychological intervention. This study is registered in Prospero (CRD42021233505).

We identified ten studies which implemented either Cogmed or a coping intervention (e.g., Coping Skills Training). Cogmed interventions showed some improvements in working memory, but the effects are not homogeneous across studies despite the similarity of methodologies. Coping interventions showed little effect on emotional processes or overall psychological health variables and were not more beneficial than control groups. No study trained or assessed both emotional and cognitive processes.

The review shows limitations in the current literature regarding the efficacy/evaluation of psychological interventions. Underlying processes are assessed by very few studies which limits the possibility of further understanding the interventions' action mechanisms. Systematically including emotional, cognitive and other underlying processes in intervention studies could help to better adjust interventions to children with CPC.

Keywords: systematic review, chronic disease, children; pediatrics, emotion, cognition

A disease or health condition which appears in childhood is considered chronic if it is highly resistant to treatment or not curable and if it has been present for longer than three months or occurs repeatedly for a long time (Mokkink et al., 2008). This definition covers many different diagnoses, including physical (e.g., cancer, cystic fibrosis, asthma, epilepsy, diabetes mellitus) and mental (e.g., ADHD, autism spectrum disorder) conditions and diseases. This systematic review will focus on chronic physical conditions only (CPCs). Experiencing a CPC during childhood presents a higher risk for the development of different emotional and behavioral disorders (Hysing et al., 2007). More generally, neurodevelopmental and neurocognitive problems have been associated with CPC during childhood (Gipson et al., 2006; Moreira et al., 2013; Silva et al., 2019). These disorders and difficulties have a significant, negative impact on quality of life of children and more generally on their psychological health. Maintaining a good psychological health is particularly important for children with CPC because it has subsequent impacts on physical subjective well-being (Silva et al., 2019) as well as on disease-related medical aspects such as treatment adherence or disease management (McNally et al., 2010) which are important aspects on their medical trajectory. In addition, psychological problems during childhood might also have a long-term impact as they have been shown to be antecedents for poor mental health in adulthood (Secinti et al., 2017).

Many psychological difficulties and disorders have common subjacent factors (Nef et al., 2012). Emotional and cognitive processes represent such underlying, transdiagnostic dimensions and have been associated with important impacts on health (Housiaux et al., 2010; McNally et al., 2010). Emotional processes such as the ability to effectively regulate one's emotions and to cope with stressful situations, are associated with positive outcomes in general mental health variables (Lahaye et al., 2013). More generally, good emotional competences, including identification, differentiation, expression, and regulation of emotions,

have shown negative associations with difficulties in social relationships and subjective physical and psychological problems in healthy children (Housiaux et al., 2010; Lahaye et al., 2013). Cognitive processes allow us to adapt flexibly to change, to concentrate and to pay attention, to solve problems, and plan actions. They also play an important role in general self-control. Thus, similarly to emotional processes, cognitive processes influence mental and physical health as well as school success and adaptation (Diamond, 2013). More specifically, they contribute to processing of emotional information (Luminet & Grynberg, 2021), disease-control and treatment adherence (McNally et al., 2010). Results from studies including children with CPCs show a higher prevalence of neurodevelopmental disorders such as ADHD, and learning disorders which are associated with an alteration of executive functions (Taha, 2017). To prevent the development of difficulties or to improve symptoms of psychological disorders, different types of interventions have been tested. Despite the large number of intervention studies, no systematic review has summarized scientific findings in this domain since 2012 (Sansom-Daly et al., 2012). In addition, the review by Sansom-Daly et al. (2012) has investigated the effects of psychological interventions on adolescents and young adults with chronic diseases only. Other authors (Plante et al., 2001) have investigated the effects of group interventions on pediatric chronic conditions, including studies with participants aged 0 to 18 years. Beale (2006) reviewed a broad scope of intervention studies for children and adolescents which included at least one psychological component. The cited systematic reviews have focused on general health variables such as quality of life (Sansom-Daly et al., 2012), psychological well-being or adjustment (Beale, 2006) without specifically focusing on underlying, transdiagnostic dimensions such as emotional and cognitive processes. However, understanding the role of these processes would provide scientific evidence for the creation and implementation of more efficient and transdiagnostic psychological interventions for

heterogeneous groups of children with CPC. Thus, in this study we aimed to review psychological interventions for children at middle-childhood (8-12 years) and their effects on emotional and cognitive processes which is critical to better understand the potential effectiveness of currently applied interventions. To update previous reviews in this topic, we also examined the potential benefits of interventions on psychological and physical health-related outcomes of pediatric patients with a diagnosis of CPC. We hypothesized that emotional and cognitive processes might represent mediating variables in the relationship between intervention and effects on psychological and physiological health.

Methods

The present systematic review was conducted according to the PRISMA statement (Liberati et al., 2009). This involved the preregistration of the review on PROSPERO (CRD42021233505). The initial preregistration included the division of the research objective in several questions. We decided to mainly address the first research question, that is, what are the effects of interventions on emotional and cognitive processes? During the data synthesis, we noticed a high number of methodological issues in the included studies, and we decided to address those as a priority. Therefore, the second (effects on psychological and somatic health) and the third research question (emotional and cognitive processes as mediators) were only addressed in a peripherical manner.

Five electronic databases (EMBASE, Cochrane Library, PubMed, PsycINFO, Scopus) were searched in March 2021. OpenGrey was also searched for grey literature. Search terms have been defined based on the PICOS criteria (Liberati et al., 2009). Five categories refer to the population, the intervention, the comparator, the outcomes of interest, and the study design. For each database, search terms were adjusted. Full search queries and

identified/included references are available online on the Open Science Framework (OSF, https://osf.io/jc2bs/).

We included studies that were published in peer-reviewed journals between January 2004 and February 2023. The date range was determined based on the systematic review of Beale (2006) whose search criteria were most congruent with the criteria used for this systematic review. Only studies written in English or French were included.

We included studies that delivered interventions to pediatric patients aged approximately 8 to 12 years. Studies were eligible if the mean age with standard deviation fell into the range of 8 to 12 years (e.g., a study with a mean age of 13 years and a standard deviation of 2 was eligible). This decision was taken because papers did not systematically report the exact age or age ranges of participants but rather mean and standard deviations which made it impossible to verify that participants matched exactly our age range criterium.

Based on the definition of pediatric chronical physical conditions (Mokkink et al., 2008), a wide of range of different diseases was included. Some examples are asthma, type 1 diabetes, cystic fibrosis, sickle cell disease, hematology, gastrointestinal diseases, cardiovascular diseases, epilepsy, and cancer. Participants with multiple diseases or with co-morbid psychopathologies were also included. Following Sansom-Daly et al. (2012), chronic pain was excluded because of its important impact on daily aversive sensations. Chronic fatigue syndrome was also excluded because, in contrast to the other conditions, it does not represent a potential life-threat. We also excluded HIV because interventions generally focus on preventative health measures and change in behavior as well as obesity because interventions often target lifestyle (e.g., Luttikhuis et al., 2009). Diseases with a major impact on motor/cognitive development of children were also excluded.

All types of interventions, irrespectively of their theoretical framework were included. Interventions were included if they explicitly aimed at modifying at least one emotional or cognitive variable (e.g., emotion regulation enhancement, attention). We included all types of delivery (e.g., face-to-face, digital-based), and intervention durations.

Only randomized-controlled trials were included in this review. All types of control groups were included (e.g., alternative intervention, waiting list etc.).

Studies were considered if they included a quantitative evaluation of at least one emotional such as emotion regulation strategies/processes (Gross, 1998), coping strategies (Folkman & Lazarus, 1984), emotional competence/intelligence (Mikolajczak, 2009) or or cognitive process such as executive functions (flexibility, inhibition, working memory), attention, memory, meta-cognition, reasoning, planification, visuo-spatial abilities (Diamond, 2013). The evaluation could be performance-based, self- or hetero-reported.

Two researchers independently screened titles and abstracts (50% by MK, 50% by CJ) and discussed uncertainties. If no agreement could be reached, a third researcher (CV, ML or OL) was consulted. All full-text articles were then reviewed by both researchers (100% by MK, 100% by CJ), disagreements were discussed with a third researcher (CV). Data extraction was carried out by three researchers (MK, CJ, and CV). MK extracted data for all studies, CV and CJ both extracted data from half of the studies respectively. Thus, all data was extracted by two researchers and extracted information were compared. We extracted data regarding participants (e.g., number, mean age, type of chronic physical condition), interventions (e.g., frequency and length of intervention sessions, type of delivery), type of control group (e.g., alternative intervention), outcomes (e.g., type of outcomes (emotional, cognitive, others), evaluation tools), effect estimates (e.g., p-values, effect sizes), and statistics (e.g., intention-to-treat/per-protocol, mediation analyses). Extracted data is summarized in Table 1 and 3. The

full selection process, the number of excluded and included studies and the reason for exclusion is depicted in the PRISMA flow diagram (Figure 1).

A narrative synthesis was chosen to report all extracted data (quantitative and qualitative). Regarding the high number of methodological limitations (e.g., lack of reported effect sizes, statistical issues), we decided not to conduct a meta-analysis.

Results

The main objective of this review was to investigate emotional and cognitive processes evaluated by intervention studies. Therefore, interventions were categorized in two different groups, based on the type of process they evaluated. In terms of processes, included studies evaluated either coping strategies or executive functions. Executive functions fall within the range of cognitive processes. However, coping strategies cannot be defined as exclusively cognitive or emotional processes and have therefore been classified as a distinct category in this review. Thus, we will refer to *coping interventions* and *cognitive interventio*ns. The 14 included papers are summarized in Table 1 and 3.

We included five papers in the category of cognitive interventions. Two papers referred to the same sample but reported on short-term (Conklin et al., 2015) and long-term (Conklin et al., 2017) effects respectively. Therefore, we referred to four studies in this category, which corresponds to five different papers. All four studies implemented the *Cogmed* intervention, which is an adaptative computerized cognitive training program focusing on working memory (https://www.cogmed.com/, also see Appendix A).

All four cognitive intervention studies (Table 1) tested the effect of the intervention on cognitive variables exclusively and differentiated between outcomes closely related to the training such as working memory (near-transfer) and effects such as attention, processing

speed and other cognitive processes (far-transfer). More general variables of psychological or somatic health were not evaluated in any of the four studies. All results can be found in Table 2.

Working memory

The evidence of treatment effects on working memory is mixed. Some of the measures were used by a single study which does not allow a thorough interpretation of general treatment effects. It is of note, however, that several studies found strong effect sizes for the reported treatment effects on working memory skills. Auditory or verbal working memory stores and processes verbal information and refers to the function of the phonological loop. All the stimuli in verbal working memory evaluations are presented verbally by the examiner and reproduced verbally by the child.

Auditory/verbal working memory showed a significant improvement from pretest to posttest in two of three studies (improvements reported by: study 3: Conklin et al., 2015, 2017 and study 2: Kerr & Blackwell, 2015; no improvement reported by study 1: Hardy et al., 2013). These results are particularly interesting as identical tests have been used by the two studies and effect sizes were medium to strong. In one study, the improved performance was maintained after six months (study 3: Conklin et al., 2017).

In the tasks evaluating visual-verbal working memory, the material is presented visually and must be recalled or recited verbally. While auditory information in the auditory/verbal working memory tasks can be transferred directly to the phonological store, visual input from the visual-verbal working memory tasks first necessitates the transformation of visual information into a phonological representation in order to store and process it in the phonological loop system. Visual-verbal working memory was evaluated only by one of the four studies (study 2: Kerr & Blackwell, 2015). The authors found a significant improvement

from pretest to posttest for *Cogmed* participants compared to waitlist participants on one out of three measures, with a large effect size.

Visual-spatial working memory allows children to recognize objects and their position/movement in space or to recall numbers and letters for example. Visual-spatial working memory evaluations are composed of visual or spatial material which has to be stored and recalled. Two studies reported on the evaluation of visual-spatial working memory (study 3: Conklin et al., 2015; study 1: Hardy et al., 2013). They both showed an improvement from pre- to posttest with strong effect sizes, and effects were maintained at a follow-up measurement (study 3: Conklin et al., 2017). Reliable change index (RCI) analyses in the study by Kerr and colleagues (2013) showed a significant improvement for the intervention group participants.

An important indicator of treatment effects can be the general working memory indexes as they include the results of several subtests which have been reported separately. Conklin et al. (2015; study 3) and Jordan et al. (2020; study 4) both reported an improvement of general working memory, but effects were not maintained after 6 months. The effect size in Conklin's study was of medium strength, Jordan et al. (2020) did not report effect sizes. Importantly, while performance-based evaluations of children showed an improvement of general working memory, parents did not note any differences in working memory skills that were evaluated with questionnaires (study 3: Conklin et al., 2015, 2017). The improvements might be specific to the tasks that were used and might have been less transferable and thus less observed in daily life situations.

Attention

The development of attention resources is important as they interact with other cognitive functions, like working memory. Attention operates to determine which information

will gain access to the working memory. This is particularly important as working memory has important capacity limits which necessitates a strict goal-driven selection of information before the latter enters the working memory system (Awh et al., 2006). This shows the importance of both processes for the child's functioning in cognitive tasks and in general daily activities. The *Cogmed* program focuses on the training of working memory skills and the exercises are designed accordingly. However, attention is a cognitive function that is, like most others, essential for the execution of complex tasks and thus indirectly trained. Indeed, it is not the quantitative increase of each function that makes a child more efficient but the coordination of different cognitive functions (Chevalier, 2015).

Auditory attention allows to selectively direct our focus towards an auditory information of interest. It is an important component of attention for maintaining a goal-directed behavior in a stimuli rich and potentially distracting environment. Auditory attention can be measured with tasks that require the participant to recite or recall previously presented, auditory information. Three studies evaluated auditory attention but only Kerr and Blackwell (2013; study 2) showed that the intervention group improved significantly from pretest to posttest, compared with the control group.

Visual attention allows to reduce the complexity of the environment by limiting the attention to only a small number of elements around us. It is essential for reading in general and more specifically for extracting important information from complex visual stimuli such as a timetable at school or a bus schedule on the way home. Only Conklin et al. (2015; study 3) reported an improvement of visual sustained attention which was maintained six months after the intervention (study 3: Conklin et al., 2017). The reported effect size was of medium size.

The only domain for which two studies showed a significant treatment effect is visual-spatial attention. The visual-spatial function is essential for identifying forms, spatial configurations and to be able to move accordingly towards or around an object or to grab it. It is also a fundamental function for orientation in the environment (e.g., being able to differentiate between left and right). The *Cogmed* intervention helped to improve the performance of children in terms of their capacity to focus their attention on visual and spatial information, to store and recall it correctly (study 3: Conklin et al., 2015; study 2: Kerr & Blackwell, 2015). The effect sizes for the short-term effect in both studies were of medium strength. However, in Conklin et al. (2017; study 3), the effects were not maintained at the follow-up measure.

Two different parent-rating scales for children's inattention (CPRS-3 and CRS-R) were used by two studies (study 3: Conklin et al., 2015, 2017; study 1: Hardy et al., 2013). Only in the study by Conklin et al. (2015) parents reported a significant improvement for children who had participated in the intervention group. The effect was maintained at the follow-up measurement at six months (Conklin et al., 2017).

Other cognitive variables

Other cognitive functions than attention and working memory were evaluated by three out of four studies (study 1-3). They give an additional indication for performance on other higher-order cognitive processes (metacognition), underlying processes (processing speed), underlying conditions such as attention deficit disorder and/or hyperactivity or general difficulties in specific learning tasks (reading, math, general learning problems). All results can be found in Table 2.

The lack of a consistent treatment effect across studies makes it difficult to draw a conclusion. However, it is interesting to look at the percentages of significant treatment effects for single test performance-based measures (no composed scores and no parent-ratings) of cognitive processes for each study. Hardy et al. (2013; study 1) reported significant short-term effects (from pretest to posttest) for one out of four measures (25 %) which were not maintained at three months. Conklin et al. (2015; study 3) reported significant short-term effects for five out of nine measures (55,5 %) of which four (45,5 %) were maintained at 6-months follow-up. Kerr and Blackwell (2015; study 2) reported significant short-term effects for four out of 12 measures (33,3 %) but did not measure long-term effects. Jordan et al. (2020; study 4) reported results through a working memory index (WISC-V) rather than through results from subtests of the test battery. Thus, a proportional comparison of significant subtests to the other studies would not be appropriate. They also included one measure of general working memory from the NTCB test battery. Both measures were significantly improved immediately after the intervention, but the effects were not maintained at 6-months follow-up. In addition, none of the far-transfer tasks measuring specific learning abilities that are used daily (e.g., reading and math skills), showed a significant change after intervention. Regarding parent-ratings, three out of eight measures (37,5 %) taken across studies showed a significant improvement.

We included nine papers that reported the implementation of interventions which mostly focused on training coping skills (Table 3). Two papers (study 5: Ambrosino et al., 2008; Grey et al., 2009) reported short-term and long-term effects, respectively, of a Coping Skills Training (CST) for the same sample. Thus, both papers refer to the same study. Another three papers (study 6: Grey et al., 2013; Jaser et al., 2014; Whittemore et al., 2012) reported short-

term, long-term and mediation effects of CST for the same sample and thus refer to the same study. In the following text, we summarized the papers that report results for the same study and sample. Therefore, we will refer to six studies in the category of coping interventions corresponding to nine papers. Information on each type of intervention can be found in Appendix B.

All results of coping interventions can be found in Table 4. All six studies evaluated coping skills but only one found a significant treatment effect (time x group interaction effect: study8: Schatz et al., 2015). The study showed that the intervention group (CBT-CST) used coping strategies more frequently and perceived pain as more controllable over time compared to the waitlist control group whose scores did not change. Effect sizes were small. The study included children with SCD and the evaluation tool for coping strategies was specific for this CPC. Schatz et al. (2015) also reported that the use of smartphone exercises on coping skills (deep breathing, progressive muscle relaxation, and guided imagery) was significantly positively associated with reports of lower pain intensity the next day but did not influence the child's daily activity level (e.g., meeting friends, going to school). Contrary to the hypotheses, the other five studies found no significant interaction effects, but several significant time (and group) effects were reported.

Ambrosino et al. (2008) and Grey et al. (2009) (study 5) evaluated children's coping difficulties regarding managing their T1D after a CST or a GE intervention. The authors found that children in both groups found it less upsetting to cope with T1D related issues three months after pretest evaluations (Ambrosino et al., 2008). Parents, who participated in parallel sessions, also found it less hard to deal with their child's disease issues at three months in both groups. An improvement in both coping skills for both groups was observed after 12 months (Grey et al., 2009). Effect sizes, when reported (Ambrosino et al., 2008), were

small. Grey et al. (2009) also tested if coping and other variables were mediators in the relationship between intervention and quality of life/metabolic control, using correlational analyses. Even though the authors showed an improvement for the subscale disease-related worry of the quality-of-life scale in both groups from pretest to 12 months follow-up, and an improvement in both groups for the subscale disease impact from pretest to three months, coping was not found to mediate these effects. The authors reported increased HbA1c levels at 12 months, indicating a worsening of metabolic control. An association with coping skills was not found.

Whittemore et al. (2012; study 6) did not report any significant change of coping in any group (Teencope or Managing Diabetes) over six months. Grey et al. (2013; study 6) reported a significant improvement of primary, secondary coping as well as a decrease of stress reactivity for both groups over 12 months. Effect sizes were not reported. Whittemore et al. (2012) showed increased HbA1c levels after 6 months only for the control group. Grey et al. (2013) reported increased HbA1c levels from baseline to 12 months, indicating a worsening of metabolic control. Based on these results, Jaser et al. (2014; study 6) tested if coping mediated the effect of the intervention on Hb1Ac levels but did not find a significant effect. Global quality of life increased in both groups over time. Diabetes-specific quality of life improved only in the control group after six months. Jaser et al. (2014) found a significant mediation effect for primary and secondary control coping as well as for stress reactivity which were associated with improvements in quality of life in the Teencope intervention group.

Grey et al. (2013) also compared participants who participated in one intervention (Teencope/Managing Diabetes) to those who participated in both, after 18 months. However, they did not report results for coping skills.

Guo et al. (2020; study 7) who implemented a modified form of the original CST, found a significant group effect when data was analyzed by age group (school-aged children: 8-12 years; adolescents: 13-20 years). The authors reported "significant improvements […] in school-aged children [8-12 years] who participated in the intervention group compared with school-aged children in the control group" at 12 months. It was not reported if differences between the groups existed at baseline for this variable.

For the other two studies (study 10: Pulgaron et al., 2010 and study 9: Scholten et al., 2013), an improvement of coping was reported, regardless of group membership. Scholten et al. (2013) implemented a psychosocial group intervention (Op Koers) with two conditions (children only and children with parents) and tested if the implication of parents in the therapy process has a benefit for children's well-being. They showed an improvement of coping skills in both intervention groups as well as in the waitlist control group, indicating that neither condition had benefits compared to the others. Pulgaron et al. (2010) reported significant time effects as well. The results show that participants both in the problem-solving intervention (PAC-T) and in the passive control group improved their problem-solving skills between pretest and posttest and between pretest and the follow-up measure.

In total, 14 out of 24 subscales showed a significant time effect from baseline to post-test/follow-up, regardless of group. One study reported a significant difference between groups at follow-up. 14 subscales showed an improvement for both the intervention group(s) and the control group with or without alternative intervention. In other words, the coping interventions did not show any benefits over a more traditional educational intervention/no intervention, and this regardless of the type of control group. No benefit for interventions that included parents was found. For two subscales, a significant interaction effect (time x group)

was found (study 8: Schatz et al. 2015). This study used a waitlist control group and evaluated sickle-cell disease-specific coping. Thus, results cannot be generalized to other populations or to more general coping skills.

All coping intervention studies except one (study 8: Schatz et al., 2015) also evaluated other variables which represent more general psychological or physiological health indicators, including quality of life, self-efficacy, self-management, social competence, depression, psychosocial problems, stress, family functioning, and metabolic control. In four out of six studies (study 7: Guo et al., 2020; study 10: Pulgaron et al., 2010; study 8: Schatz et al., 2015; study 9: Scholten et al., 2013) the authors did not differentiate between process variables (e.g., coping, self-efficacy) and more general variables of well-being, psychological or physiological health but considered all variables at the same conceptual level. In addition, these four studies did not establish any link between the evaluated constructs. All results can be found in Table 5.

Discussion

We have exposed the results of 14 articles that reported the results of psychological interventions for children with CPC. We will now discuss these results and their implications, methodological limitations including statistics, recruitment, evaluation tools and control groups, as well as theoretical and conceptual aspects of the interventions and measurements, and present perspectives for researchers and practitioners.

Cognitive intervention studies included in this review evaluated a multitude of different cognitive processes. Thirty six percent of single test child performance-based measures showed a significant improvement immediately after the training but only 12% of the total number of measures showed a significant improvement in the long-term (three to

six months). Three out of nine (33%) parent-reported measures showed a significant improvement at posttest of which two were maintained after six months. In summary, the papers in this category show limited evidence for the effectiveness of Cogmed for children with CPCs.

The benefits of brain-training programs like Cogmed for clinical samples and typically developing children (and adults) have previously been evaluated and show mixed results. Reliable short-term benefits on verbal and visuospatial working memory have been reported (Melby-Lervåg & Hulme, 2013) with moderate to large effect sizes (for verbal working memory effect sizes range from *d* = .72 to *d.* = .84; for visuospatial working memory effect sizes range from *d* = .44 to *d* = .55). Overall, the training effects on verbal WM were not maintained at follow-up (on average nine months after posttest evaluations). Effects on visuospatial WM were maintained after an average of five months with medium effect sizes (mean effect size: *d* = .41). It must be noted that some of these effects were small at an immediate posttest evaluation and increased in strength at follow-up. The explanation for this type of effect remains unclear and results must be interpretated with caution. For far-transfer measures (not trained processes like non-verbal ability, inhibitory processes, arithmetics), effect sizes were small (*d* = .13) to moderate (*d* = .32) and mostly not significant at immediate posttest evaluations. All long-term effects (3.3 to 7.8 months after posttest) on far-transfer measures were small and nonsignificant. These results were consistent across studies.

In summary, as also confirmed in the large review by Simons et al. (2016), there is no evidence that working memory training has immediate or delayed benefits on far-transfer measures (beyond the trained tasks). The meta-analysis by Melby-Lervag & Hulme (2013) as well as the review by Simons et al. (2016) also noted that many studies did not have robust

study designs (e.g., small sample sizes, untreated controls, non-randomized, large batteries of outcome measures).

In the studies included in the current review, most of the cognitive variables evaluated were closely related to the training. In other words, evaluated processes were also those which were trained, and the type of evaluation was similar to the trained task. The studies generally distinguish between “near-transfer” effects and “far-transfer” effects. While “near-transfer” measures refer to tasks which share many elements with the task that was practiced during the program, “far-transfer” measures refer to tasks which share fewer elements with the trained tasks. Such far-transfer effects were not or rarely evaluated, and it is difficult to estimate to which extent the Cogmed intervention had benefits for the children in their daily life. Simons et al. (2016) illustrate, through formal discipline and transfer by identical elements theories that the transfer of learned skills from a training program to real life abilities is not as direct as one may expect. More recent theories recognize the importance of the context of learning and the interactions that might be at stake between the content of the learned elements and the context in which the learning and transfer take place. The complexity of such interactions is mostly ignored by brain-training companies which claim the efficacy of their product for a multitude of difficulties and outcomes. To summarize, the exact mechanisms of the transfer of learned skills remain unknown. Thus, “in the absence of a complete understanding of the nature of these underlying mechanisms and without a full description of the role of context, these [claims] are necessarily somewhat subjective” (Simons et al., 2016).

In total, two out of 24 coping subscales showed a significant interaction effect between time and group. It is important to note that two papers used a questionnaire (IC-IDDM) that

evaluates the psychological difficulties of dealing and coping with T1D rather than the use of coping itself. We decided to keep this study which was reported in two articles (study 5: Ambrosino et al., 2008 and Grey et al., 2009) because this evaluation still dealt with the concept of coping, albeit indirectly, and because of the scarcity of literature in this field of research. Considering the characteristics of interventions, it might be plausible that both types of intervention (CST and educational) diminished the extent to which children found it upsetting or difficult to manage their disease. However, this does not necessarily mean that their coping skills improved. The other papers reported a significant increase of the use of adaptive coping skills for both groups but no advantage for the coping intervention participants over participants who participated in a diabetes education program, in a waitlist control or a treatment-as-usual group.

The efficacy of psychological interventions for pediatric chronic diseases has been reported in different systematic reviews which showed mixed results (Beale, 2006; Plante et al., 2001; Sansom-Daly et al., 2012). Sansom-Daly et al. (2012) reported that 57% of coping skill interventions for adolescents and young adults showed medium to large significant effects. In the category of coping skills programs with multifamily or parental involvement 83% of interventions showed medium to large positive effects on different psychosocial outcome measures (not detailed in the report). Peer-involvement in the program did not increase its efficacy. Beale (2006) also reported large improvement in outcome measures for about 80% of the participants. The authors report an overall mean effect size (.71) based on the difference in outcome variables (symptoms and physiological variables, illness knowledge, psychological adjustment, self-care and coping, behaviors, and attitudinal variables) between pre- and postintervention means in the intervention group. Analyses did not show differences between different types of CPCs. However, only a few intervention studies met basic validity

criteria, which limits the interpretability of results. Another review on group interventions for pediatric CPC (Plante et al., 2001) reported positive trends for adolescents with diabetes and survivors of childhood cancer in terms of psychosocial functioning, using adaptation/skill development groups (e.g., targeting coping or disease management). Some other types of group interventions (e.g., emotional support group, summer camps) showed mixed results and their interpretation was limited by weak study designs. It also must be noted that studies often did not evaluate or report measures that were closely related to the intervention's objective (e.g., a family-focused intervention should evaluate family adjustment), and only studies that achieved positive outcomes appeared to establish a clear link between objective and measurement which might lead to a bias in the interpretation of results.

In the current review, although the training of coping skills was the focus of the intervention studies included in this category, evaluations did not show any benefits of the programs for the use of coping strategies with one exception (study 8: Schatz et al., 2015). One might hypothesize that the implemented interventions did not impact coping processes but that, instead, other factors might have benefited from the training. For example, more general variables (e.g., quality of life) could show improvements. However, studies did not report a systematic improvement of those variables either. In addition, one study (study 7: Jaser et al., 2014) showed that coping processes could be considered as mediator in the effect of interventions on general health variables, which supports the hypothesis that emotional process variables play a role in the psychological well-being of children with CPCs. It also shows the importance of including mediation analysis in efficacy research as this allows understanding the mechanisms of change behind an intervention and, consequently, to target those mechanisms more specifically in future research and interventions.

Methodological issues

Statistics and results

There was substantial variability between studies in using robust statistical procedures. Most of the studies did not correct for multiple comparisons and half of the studies did not report effect sizes. Moreover, in some studies we found inconsistencies in results that were reported in the tables and in the text. In several studies, it was either unclear which or how statistical tests were used (e.g., no random effects were included although the statistics used was a "mixed model"). In addition, in several studies, the way results were reported was inconclusive. For a complete overview see Table 6.

Inclusion of participants

All studies except one (study 9: Scholten et al., 2013) included participants with one specific CPC. Accordingly, as mentioned above, interventions and questionnaires/tasks were chosen or designed for that specific population. This follows the idea that CPCs are so different in their nature that a comparison across CPCs is hardly possible. Plante et al. (2001) argued that it has yet to be demonstrated that homogeneous groups have clear advantages in terms of intervention efficacy. On the contrary, transdiagnostic approaches have shown that including children with different CPCs has several advantages. It allows the inclusion of children with rare diseases for which classical intervention approaches do not exist. It thus facilitates the creation of intervention programs that can meet the needs of many children (Stein & Jessop, 1982). This can also further multisite collaborations, allowing for an increase in sample sizes which in turn would improve the reliability of results (Sansom-Daly et al., 2012). Differences in diagnoses, prognoses, or sites can be controlled in statistical analyses. This approach also emphasizes the similarities rather than the differences in terms of functional limitations (e.g., missing school, hospitalizations, limited free-time activities) and

the psychosocial consequences (Silva et al., 2019), positioning the child in their interpersonal system (Chu, 2012). In the current review, Scholten et al. (2013; study 9) is the only study that included children regardless of the type of CPC and designed a questionnaire that evaluated "disease-related coping skills" with disease-related questions which apply to any type of CPC (e.g., "I know how to get answers to questions concerning my disease" or "When I am nervous about going to the hospital, I am able to relax myself"). Illness type and severity were tested as potential moderators of the treatment effect, but analyses did not show a significant moderation effect, illustrating that children with different types of CPC might not necessarily experience interventions differently. Beale (2006) also underlined that specific types of CPC were not associated with larger effect sizes than others which is another indication for broader inclusion criteria regarding types of CPCs. Nevertheless, while widening the scope of types of CPCs, it would be adequate to limit the age-range of participants in order to avoid large developmental gaps and comparisons between non-comparable developmental stages (Sansom-Daly et al., 2012). Many studies in this literature, indeed, include participants within a large age-range (e.g., 8-21 years).

We do not claim that one approach is better than the other but want to stress that both approaches are possible, have specific benefits and should be considered by researchers. Another aspect that is worth being mentioned is that only two studies included participants based on evidenced cognitive difficulties (study 3: Conklin et al., 2015, 2017; study 1: Hardy et al., 2013) as measured before study inclusion. All the other studies either did not select participants based on difficulties in the trained domain or did not report it. This is problematic in the sense that cognitive or affective difficulties are hypothesized and the decision for the need for an intervention is taken based on this hypothesis. We could hypothesize that this is, at least partly, the reason for the lack of systematic improvements and could explain why

benefits were reported even for passive control participants in some studies. The main question that arises in this context is whether the included children need psychological support. Even if the interventions are sought to be preventative rather than curative, their usefulness is not guaranteed. To address this problem, a screening of children (and/or families) prior to study inclusion could help to estimate resiliency and thus the need for different types of psychological support (Kazak et al., 2015). While some might benefit most from a thorough therapeutical intervention, others might benefit more from general psychoeducation or family-centered support. In addition, a comparison of evaluation results to norms of typically developing children could help the reader to better understand the meaning of each score. Besides the apparent clinical benefits of such an approach, the latter would also have a significant impact in terms of financial resources, which would be allocated to populations who are in need.

This leads us to another aspect regarding the consideration of participants in their individuality. Indeed, individual differences are not or rarely taken into consideration by studies. Different risk and protective factors shape the differences between individuals in terms of their psychological needs at a specific time point (Cicchetti & Rogosch, 1996; Kazak et al., 2015). To recognize these differences and address the variety of needs a fine analysis of the latter is required before an intervention is proposed to a child. However, at present, it seems like children are integrated into intervention programs based on an availability-of-treatment principle. In other words, an intervention is made available, and children are matched to the interventions rather than the opposite (match interventions to the particular needs of (a group of) children). Thus, it remains unclear which intervention is suitable for whom (Beale, 2006) and this issue might have limited the benefits of the interventions presented in the current review. Although the current methodology is a first goop step and

highly valuable for research purposes, the further development in the near future of more suitable programs is indispensable.

Evaluation tools

Most evaluation tools used by the different coping intervention studies were designed for a specific chronic disease. These measures usually include symptom (e.g., pain controllability in sickle cell disease) or treatment (e.g., coping with the management of treatment-related issues) specific questions. In addition, some interventions were designed for one specific CPC (e.g., CST for T1D) and focused on topics related to the disease. These interventions and tools are highly interesting for investigating a specific disease, but Sansom-Daly et al. (2012) reported that disease-specific measures do not systematically offer an advantage over more general measures. In the context of this systematic review, it is difficult to compare studies focusing on different CPCs. Studies could more systematically include both disease-specific and general measures in order to make treatment effects comparable to other studies implemented the same intervention.

All cognitive intervention studies used a general cognitive training which is also used in other populations. In addition, authors included general cognitive test batteries (e.g., WISC-V, WMTB-C), making a comparison between studies easier. However, not many studies used the exact same subtests to evaluate different cognitive domains and several subtests were often used to evaluate different aspects of the same function (e.g., working memory).

Type of control group

Seven of the ten included studies used a passive control group (waitlist or treatment as usual). Only one cognitive intervention study used an active control group which received MegaMemo instead of Cogmed (study 1: Hardy et al., 2013). The difference between the two

interventions is that the program MegaMemo does not adjust its difficulty level to the actual performance of the child. Two out of six coping intervention studies implemented an alternative intervention for the control group (study 5: Ambrosino et al., 2008 and Grey et al., 2009; study 6: Grey et al., 2013; Jaser et al., 2014; Whittemore et al., 2012). Managing Diabetes and General Education were specifically designed for teenagers with T1D and were very similar to the main intervention (CST and Teencope) in that they focus on problem-solving skills which is also a coping mechanism. The main difference was that the control interventions focused on T1D-related situations as opposed to all types of situations in a child's life. It was not systematically reported by studies that used passive controls what children in the waitlist or treatment as usual group did. In the context of clinical populations, children are likely to receive at minimum a standard of care or regular support from various health professionals. However, the reader can only make hypotheses about this as authors did not give any details.

It might seem intuitive to conclude that the use of passive control groups is a methodological limitation as it does not allow to estimate the amount of so-called "non-specific" or placebo effects. However, the matter is more complex, and a recent meta-analysis on cognitive intervention studies has shown no difference between active and passive control groups (Au et al., 2020). In other words, there is no evidence that the type of control group significantly influences the effect size from quantitative evaluations. One hypothesis to explain this observation is that active control conditions might have been insufficiently designed. Indeed, the distinction between an experimental and a control task is often very blurry and depends on each researcher's definition. The authors state that "…while this "active" control may control for non-specific intervention effects related to experimenter contact and time spent on a task, other potentially influential factors differ between groups such as perceived cognitive effort and expectations of improvement" (Au et al., 2020).

Further, (Kirsch, 2005) suggests that designing a “placebo-intervention” in psychotherapy is almost impossible as the concept is hardly applicable to psychology. Originally used in medical research, the goal of a placebo treatment is to control for the effects that might be produced by the treatment on a psychological level. Thus, according to Kirsch, “most psychotherapy is a placebo by definition”. He suggests that rather than comparing the effects of an experimental intervention to effects observed in a control group to estimate the former’s efficacy, researchers should use the comparison to learn more about how and why the intervention works or does not work. In other words, relying on active control groups to judge the quality of a study is not sufficient. Instead, the assessment of underlying factors and processes, such as the experimenters’ and participants’ expectations and motivation for example, could help to better understand differences between active control and experimental groups.

In conclusion, it is not appropriate to discard studies with passive control groups based on the assumption that passive control group participants perform differently than active control participants, at least in the context of psychology research. In addition, active control groups are not a guarantee of quality if the latter are not well-designed.

Sansom-Daly et al. (2012) and Plante et al. (2001) reported that many intervention studies were non-randomized or non-controlled studies. In this systematic review, we only included RCTs. Regarding the small number of studies included, we can hypothesize that many more intervention studies might have been published since 2004 which are non-randomized or non-controlled, reflecting an important deficiency in the application of rigorous methodological standards in this literature.

Theory & Conceptualization of interventions

Several theory-related issues are discussed in this section. First, regarding the theoretical background of interventions and the conceptualization of the evaluated variables, we have noticed that most interventions were only partly theory driven. Second, action mechanisms or mechanisms of change have not been, or rarely been defined and evaluated as such. In addition, most interventions did either not establish a link between process variables and benefits in the child's daily life or do not distinguish between process variables (which could be explicative variables of change) and outcome variables (such as psychological well-being which could be explained by process variables). Third, both types of interventions lack another element: the consideration of the overlap and interaction of cognitive and emotional processes.

Underlying theory & mechanisms of change

We have noticed a lack in the construction of interventions based on a specific theory or concept and, thus, a lack of the interrogation of action mechanisms of interventions. Just like Sansom-Daly et al. (2012) stated in their systematic review, the studies included in the current review were not clear about which key elements of their interventions were supposed to affect change. In this debate, we must distinguish, once again, between the studies that we classified in the cognitive intervention category and those in the coping intervention category.

Cognitive interventions (here Cogmed) are based on the assumption that cognitive processes underlie difficulties experienced by children with CPC and that by changing these processes, it is possible to enhance general functioning in daily tasks (e.g., learning, reasoning). The most striking lack in this literature is that a link to daily tasks has not been established. As mentioned before, it is hypothesized that the training of specific cognitive skills directly impacts cognitive performance on other tasks and on the individual's behavior in life.

Cogmed advertises larger benefits such as helping with difficulties like “making careless mistakes”, “finding it hard to organize and plan ahead”, or “completing tasks that require multiple steps” (https://www.cogmed.com/). Although many scientific studies have evaluated the Cogmed program, it remains unclear on which theory the program is built. Neither the Cogmed website nor the individual studies provide any information about conceptualization or refer to a specific reference in scientific literature.

Regarding the category of coping interventions, the issue is a little different. Studies generally refer to a specific theory (e.g., social cognitive theory), concept (e.g., stress-adaptation model), or type of therapy (e.g., CBT) on which the intervention is built. However, they do not define or detail in the research paper how the intervention is supposed to work and for whom. Action mechanisms are not explicitly named and/or evaluated.

We believe that the recommendation by Sansom-Daly et al. (2012) that “future intervention studies should more clearly delineate, measure, and report both the proposed mechanisms expected to underlie intervention success, as well as the outcomes reflective of this change” is still applicable today and to the included studies in this review. In order to do that, it also needs to be defined what psychological adjustment in chronic disease means and how it can be reached. Only a theory-driven scientific practice that has been confronted with clinical realities can respond to the objective of improving children’s psychosomatic health. While intervention can precede theory, the interpretation of efficacy of such interventions has to be cautious and must be completed by theory (Simons et al., 2016).

Link to general health variables

In the category of cognitive interventions, studies evaluated exclusively cognitive processes but did not include any variables allowing us to understand the effects on the children’s general psychological and physical health. As mentioned before, this is an important

limitation of this part of the literature as we cannot estimate the effects of the intervention on the functioning of children beyond the cognitive training. To ameliorate these aspects, future studies must focus on understanding the links and interactions between laboratory tasks and real-life performance (Simons et al., 2016). Interventions have to be adjusted accordingly to increase changes that matter in the child's daily life.

While coping intervention studies evaluated general psychological and somatic health variables like quality of life, self-management, family functioning, or glycemic control, most of them did not establish a link between the latter and process variables such as the use of coping strategies. Process variables were not considered as playing a different (possibly a mediating) role than other dependent variables evaluating well-being or disease-management. Two studies (study 5: Grey et al., 2009; study 6: Whittemore et al., 2012 and Jaser et al., 2014) established a conceptual framework defining coping strategies as potential mediators between the intervention and its effects on quality of life and metabolic control. Thus, the authors applied a processual approach which has several advantages. Including process variables in the evaluation of interventions' efficacy allows us to look further than a psychiatric or medical diagnosis given to a child, which can differ largely between situations, cultures, and professionals. It allows to account for individual differences and acknowledges that different disorders can rely on the same processes and can thus be treated in a similar manner.

Simply approaching a topic from a categorical approach in the sense of grouping participants with the same diagnosis rather than grouping them based on similar psychological difficulties does not give any explanation about the underlying processes at stake of a disorder or the reason for efficacy/inefficacy or intervention (Nef et al., 2012). In the included studies, children have not been grouped based on a psychiatric diagnosis but based on their medical condition. This approach supposes that children with the same CPC will have similar

psychological difficulties (concept of equifinality). While this might be true to a certain degree (e.g., children with the same CPC might live through similar experiences related to the treatment of their CPCs), this approach ignores individual differences in the subjective experience of the disease and the differential impact that it might have on present and future psychological functioning (concept of multifinality; Cicchetti & Rogosch, 1996). As mentioned before, including participants based on a diagnosis also has other limits which could be addressed by a transdiagnostic approach, based on specificities of processual functioning.

More generally, it has also been recommended to include moderator and mediator analyses more systematically in RCT as they allow to better understand how and for whom the interventions work, to understand the mechanisms of change which are responsible for changing the individual's behavior and subsequently their health (Kraemer et al., 2002).

Cognition & Emotion

We categorized studies based on the type of process (cognitive or coping) they evaluated and targeted. This decision was taken based on the observation that no study included the training or evaluation of both emotional and cognitive processes. The two concepts (cognitive and coping) were considered independently from each other, following a clear delimitation of the branches of psychology to which they are central, namely cognitive and health psychology, respectively. Their interaction and integration have not been addressed in this literature. The theoretical consideration of the interaction of cognitive and emotional functions and its practical implications is lacking.

Literature from other psychological domains supports the hypothesis that emotional and cognitive processes are intertwined (Phelps, 2006). The literature has shown that emotion and cognition are highly interactive and that a clear distinction between the two is not possible

(Pessoa, 2008). For instance, Gray et al. (2002) have shown that “at some point of processing, functional specialization is lost, and emotion and cognition conjointly and equally contribute to the control of thought and behaviour.” Leerkes et al. (2008) have supported this perspective in early development. Other authors have supported the idea that individuals can change their interpretation of specific situations which in turn can modify their emotional reaction. Gross (2002) for example considers in his process model of emotion regulation that reasoning can change emotional reactions. He also showed that the use of emotion regulation strategies can have an impact on cognition (e.g., the use of suppression has a detrimental effect on memory), which further supports the hypothesis that cognition and emotion are not independent. On the other side, emotional processes can organize and facilitate other psychological processes such as cognitive ones (Cole et al., 2004). During childhood, regulatory processes of the caregiver have a direct influence on the development of regulatory processes of the child which in turn contribute to differences in cognitive processes (Bell & Wolfe, 2004). Blankson et al. (2013) have found dynamic interdependencies between cognitive control, understanding, emotion understanding, and emotion control. Other authors have underlined that neural mechanisms that underlie emotion regulation might be the same as those that underlie cognitive processes (Bell & Wolfe, 2004; Blankson et al., 2013). To summarize, we can say that the interactions are complex, both on the psychological and neural level of behaviors which are defined as emotion or cognition.

In addition, regarding affective functioning, emotional processes were only evaluated through the concept of coping. Coping, following the definition by Folkman and Lazarus (1984), describes cognitive and behavioral efforts of an individual to anticipate and detect potential stressful elements or to prevent, minimize or control the demand that comes from the transaction between person and environment, and which is evaluated as exceeding the

resources of the person. In health psychology, the concept is commonly used because the experience of physical illness or health service-related experience are considered as being potentially stressful which necessitates the use of coping processes. However, we argue that the use of coping exclusively to evaluate emotional processing is limiting as it is related to stress. Children (and adults) experience different types of situations, of positive and negative emotional nature. Other concepts such as emotion regulation or emotional competencies could therefore complete the understanding of the emotional functioning of children with CPCs. Emotion regulation has been defined by Gross (1998, see Compas et al., 2014) as the process by which individuals influence which emotions they have, when they have them, and how they experience these emotions." Emotion regulation is a central aspect of emotional functioning and can take the form of intrinsic and extrinsic regulation, that is, the regulation by the child and the regulation by a caregiver (e.g., soothing; Thompson, 1994). While coping may also involve extrinsic factors such as social support, it can only be carried out by the person who is experiencing the stress. This aspect is particularly important when conducting studies with (young) children because the younger the child, the more important the role of the caregiver who shows examples of regulation and helps the child to experience different types of emotions in a safe context. On the contrary, coping is considered as an exclusively intrinsic effort to deal with stress and has mainly been studied in later childhood and adolescence as it is linked to the maturation of cognitive processes (Compas et al., 2014). Having these conceptual differences in mind, it seems almost surprising that in health psychology research on relatively young children only the concept of coping is used.

Another concept that could complete the approach of emotional functioning in children with CPC are emotional competencies. The concept of emotional competences is more inclusive than emotion regulation as the first one also covers a range of emotional

processes that happen before and after the regulation. More specifically, it has been divided into six domains: identification, understanding, expression, analysis, regulation, and use of one's own and others' emotions. The concept of emotional competencies has been used in distinction to emotional intelligence and alexithymia which cover different ranges of emotional processes. Emotional competencies, especially in the context of developmental research, can help to better understand emotional functioning as a whole and related processes such as cognitive or social ones.

Perspectives

The practitioner reader might wonder which message to take home regarding the benefit of implementing an intervention for their patients with CPC. Here are some suggestions:

1. The benefits of the proposed interventions on psychological and physical health are ambiguous. In other words, the interventions do not do any harm, but they also do not do much good (e.g., (Simons et al., 2016).
2. By looking into the details of the interventions, it might be possible to find specific variables which are interesting targets in clinical practice. However, it is questionable if this justifies investing resources for the implementation of an entire intervention program.
3. It also seems to us that, before the implementation and evaluation of interventions, a better identification of children's needs is necessary. The latter can then lead to specifically designed interventions. Therefore, future studies should identify risk and protective factors and systematically include underlying processes and their interactions. In other words, we should give ourselves the possibility to distinguish the

families who are at high risk for developing psychological difficulties from those who are very resilient and only need care services very sporadically (see Kazak, 2006).

4. If the methodologies were more robust (especially in the coping intervention category) and if variables would have allowed the evaluation of real-life impacts (especially in the cognitive intervention category), interventions might have been judged as more beneficial, or, at least, as more reliable indicators for the observed effects.
5. Including process or mediating variables such as emotional and cognitive processes in the evaluation of interventions, could allow to better understand and address the needs of children with CPCs and improve psychological care. This should be kept in mind for theoretical considerations in clinical practice.

The researcher reader might wonder what this implies for her/his future research. A non-exhaustive list:

1. We consider this systematic literature review as the first step towards improving the quality of studies and reflecting on the conceptual and practical approach in the implementation of interventions for children with CPCs and invite other researchers to join this approach. This includes:
    a. Systematically use well-designed active control groups.
    b. Follow standard norms for statistical analyses and result reporting (e.g., multiple comparisons, effect sizes).
2. We recommend broadening the theoretical scope pediatric health psychology refers to (e.g., emotion psychology).
3. Implicate users (children, families, health care professionals) in the development and implementation of interventions through action-research.

4. Increase sample sizes through collaboration between sites and by broadening the inclusion criteria (e.g., include different types of CPC) while being attentive to the coherence between study objectives and developmental challenges (e.g., decrease age ranges).
5. Increase the time between the last intervention session and follow-up to get a better estimation of real long-term effects.

Conclusion

To summarize, the current literature does not systematically investigate or establish a link between outcome and process variables in interventions for children with CPCs. Thus, the exact mechanisms of change remain unknown, and it is difficult to establish conclusions about their nature or the possibility to target them. Future research must focus on mediating processes to elucidate the "black box" between, sometimes well-designed, interventions and psychosocial and psychosomatic changes.

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Figure 1

Prisma Flow diagram summarizing study identification, screening, and inclusion

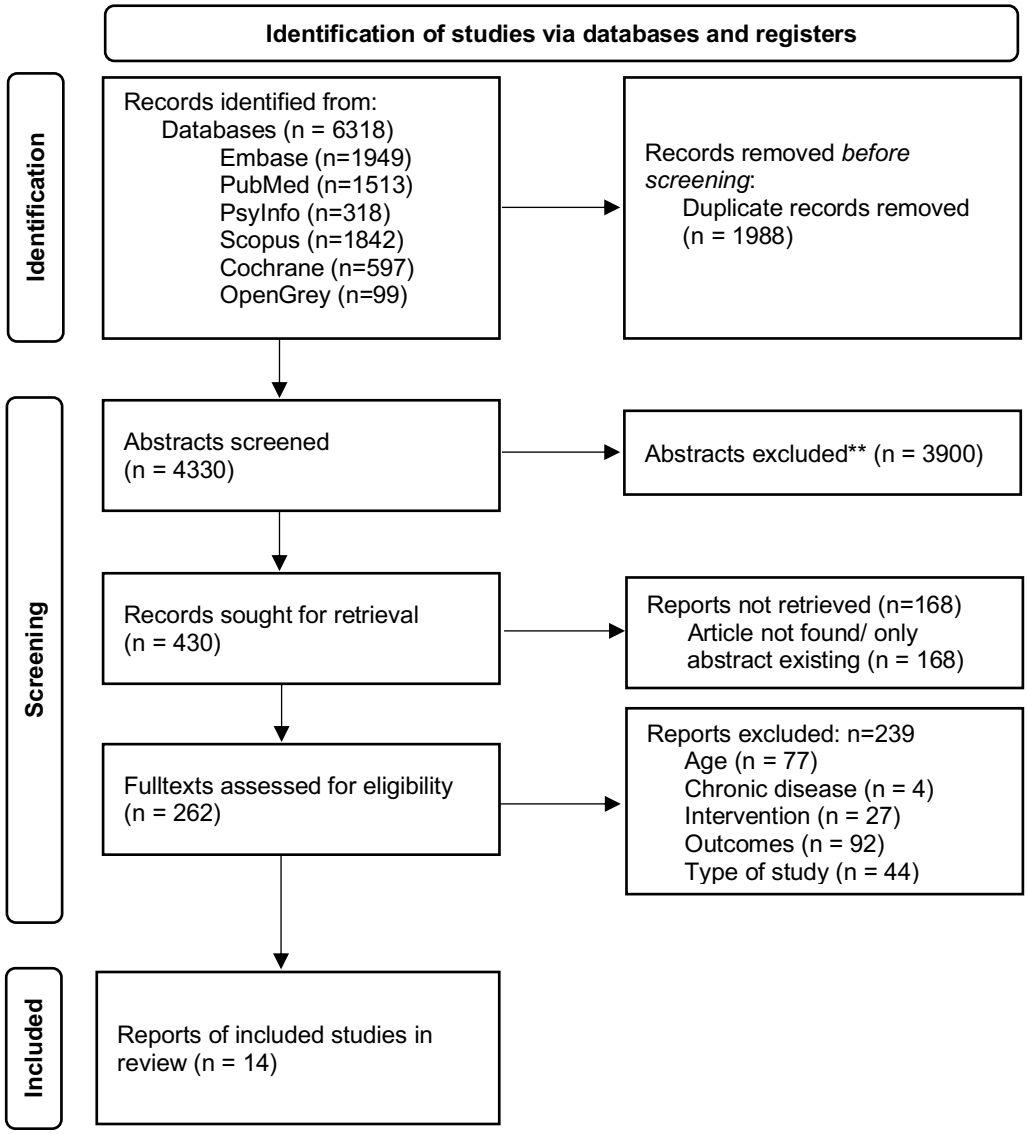

Table 1

Cognitive interventions – study characteristics

Study	Authors	Intervention	Sample	Analyses
1	Hardy et al., 2013	Cogmed; 5-8 weeks; o, i; Active CTRL: MegaMemo; 5-8 weeks; o, i	CancS; 8-16 years; N=20	Per-protocol; ANCOVA, controlled for baseline and IQ scores
2	Kerr and Blackwell, 2015	Cogmed; 5-7 weeks; o, i; Waitlist CTRL	Epi; 6.5-15.5 years; N=77	Intent-to-treat + per-protocol; univariate ANCOVA
3	Conklin et al., 2015 [a]	Cogmed; 5-9 weeks; o, i; Waitlist CTRL	CancS; 8-16 years; N=62	Per-protocol; repeated-measure ANOVA
3	Conklin et al., 2017 [a]	Cogmed; 5-9 weeks; o, i; Waitlist CTRL	CancS; 8-16 years; N=62	Per-protocol; piecewise linear mixed-effects models [b]
4	Jordan et al., 2020	Cogmed; 5 weeks; o, i; Waitlist CTRL	HLHS; 8-16 years; N=20	Intent-to-treat; Mixed model (cross-group mean-constraint function and full information maximum likelihood estimation)

Note. Intervention column: Name of intervention; duration of the intervention; o=online; i=individual; Control condition (CTRL=control). Sample column: Chronic physical condition: CancS=Cancer Survivors; Epi=Epilepsy; HLHS=Hypoplastic left heart syndrome; age range of participants; N=number of participants included in statistical analyses. Analyses column: Data inclusion approach: Per-protocol/intent-to-treat analysis: While an intent-to-treat-analysis aims at preserving the original randomization to avoid bias due to exclusion of participants, a per-protocol analysis aims at identifying a treatment effect which would occur under optimal conditions. Thus, the first includes all participants as originally allocated after randomization, and the latter includes only participants who completed treatment; type of statistical analysis.

[a] Conklin et al. 2015 and 2017 refer to the same study with the same sample. Conklin et al., 2015 reported short-term effects only. Conklin et al., 2017 reported both short-term and long-term effects.

[b] Conklin et al., 2017 also used these statistics to confirm the treatment effects observed by Conklin et al., 2015. Analyses showed significant results for the same variables as in Conklin et al., 2015.

Table 2
Cognitive interventions - results

Domain evaluated	Task/Scale	Study	Effect of intervention p-value; effect-size
		Working memory	
Auditory/Verbal WM	WRAML2, Verbal Working Memory	[**1**] Hardy et al., 2013	0-post ↑; p = .71; d = -.12 0-3 ↓; p = .65; d = -.21
	WMTB-C, DRB	[**2**] Kerr et al., 2015	Intent-to-treat: 0-post ↑*; p < .001; d = .95; Per-protocol: 0-post ↑*; p < .001; d = .93
	WMTB-C, LR	[**2**] Kerr et al., 2015	Intent-to-treat: 0-post ↑; p = .295; d = .17; Per-protocol: 0-post ↑*; p = .006; d = .67
	WISC-IV integrated, DSB	[**3**] Conklin et al. 2015	0-post ↑*; p = .017; d = .62
		[**3**] Conklin et al., 2017	post-6 = ; p = .315
	WISC-IV integrated, Letter-Number Sequencing	**[3]** Conklin et al. 2015	0-post ↑; p = .114; d = .41
		[**3**] Conklin et al., 2017	0-post ↑; p = .088 post-6 ↓; p = .948

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Table 2 *(continued)*

Visual-verbal WM	WMTB-C, CR	[**2**] Kerr et al., 2015	Intent-to-treat: 0-post ↑*; *p* = .003; *d* = .80 Per-protocol: 0-post ↑*; *p* = .001; *d* = .99
	WISC-IV integrated, VDS	[**2**] Kerr et al., 2015	Intent-to-treat: 0-post ↑*; p* = .057; *d* = .58 Per-protocol: 0-post ↑; *p* = .650; *d* = .35
	TEA-Ch, Creature Counting Accuracy	**[2]** Kerr et al., 2015	Intent-to-treat: 0-post ↑*; p* = .063; *d* = .40 Per-protocol: 0-post ↑; *p* = .309; *d* = .21
Visual-spatial WM	WISC-IV integrated, SSPB	**[2]** Kerr et al., 2015	Intent-to-treat: 0-post; *p* = .119; *d* = .49 Per-protocol: 0-post ↑*; *p* = .040; *d* = .69
		[3] Conklin et al. 2015	0-post ↑*; *p* = .002; *d* = .84
		[3] Conklin et al., 2017	0-post ↑*; *p* = .001 post-6 = ; *p* = .940
	WRAML2, symbolic working memory	**[1]** Hardy et al., 2013	0-post ↑*; *p* = .05; *d* = .94 0-3 ↑; *p* = .08; *d* = 1.22
General WM	WISC-IV integrated, WMI	**[3]** Conklin et al., 2015	0-post ↑*; *p* = .022; *d* = .60
		[3] Conklin et al., 2017	0-post ↑* ; *p* = .017 post-6 ↓ ; *p* = .923
	WISC-V	**[4]** Jordan et al., 2020	0-post ↑*; *p*=.049 0-6 ↓; *not reported*
	BRIEF, general working memory index; *parent-rating*	**[3]** Conklin et al. 2015	0-post ↑; *p* = .157 ; d = .36

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Table 2 *(continued)*

		[3] Conklin et al., 2017	0-post ↑ ; p = .223 post-6 ↑ ; p = .214
	NTCB List sorting	**[4]** Jordan et al., 2020	0-post ↑* ; p = .002 0-6 ↓*; not reported*
		Attention	
Auditory attention	WMTB-C, DRF	**[2]** Kerr et al., 2015	Intent-to-treat: 0-post ↑*; p = .019; d = -.052 Per-protocol: 0-post ↑*; p = .804; d = .17
	WISC-IV integrated, DSF	**[3]** Conklin et al. 2015,	0-post ↑ ; p = .897 ; d = .03
		[3] Conklin et al., 2017	0-post ↑ ; p = .897 post-6 ↑ ; p = .561
	WRML2, Number-Letter task	**[1]** Hardy et al., 2013	0-post ↑; p = .58; d = .28 0-3 ↑; p = .90; d = -.05
Sustained auditory attention	TEA-Ch, Score !	**[2]** Kerr et al., 2015	0-post ↑ ; *not reported*
Visual attention	WRML2, Finger Windows	**[1]** Hardy et al., 2013	0-post ↑; p = .18; d = .67 0-3 ↑; p = .59; d = .30
Visual sustained attention	CPT-II, omissions	**[2]** Kerr et al., 2015	0-post ↑ ; n*ot reported*
		[3] Conklin et al., 2015	0-post ↑* ; p = .036; d = .56

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Table 2 *(continued)*

		[3] Conklin et al., 2017	0-post ↑* ; *p* = .015 post-6 ↓ ; *p* = .055
	CPT-II, variability ratio	**[2]** Kerr et al., 2015	0-post ↑ ; n*ot reported*
Visual-spatial attention	WISC-IV integrated, SSPF	**[2]** Kerr et al., 2015	Intent-to-treat: 0-post ↑*; *p* = .001; *d* = .76 Per-protocol: 0-post ↑*; *p* = .005; *d* = .75
		[3] Conklin et al., 2015	0-post ↑* ; *p* = .012; *d* = .65
		[3] Conklin et al., 2017	0-post ↑* ; *p* = .014 post-6 ↓* ; *p* = .049
Selective attention	ACT	**[2]** Kerr et al., 2015	Intent-to-treat: 0-post ↑; *p* = .483; *d* = -.13 Per-protocol: 0-post ↑*; p* = .213; *d* = .38
Inattention	CPRS-3 ; *parent-rating*	**[1]** Hardy et al. 2013	0-post ↑; *p* = .20; *d* = .40 0-3 ↑; *p* = .26; *d* = .21
		[3] Conklin et al. 2015	0-post ↑*; *p* = .009; *d* = .68
		[3] Conklin et al., 2017	0-post ↑* ; *p* = .019 post-6 ↑ ; *p* = .851
	CRS-R ; *parent-rating*	**[2]** Kerr et al. 2015	0-post ↓ ; *not reported*

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Table 2 *(continued)*

		Other cognitive variables	
Processing speed	CPT-II, reaction time	**[3]** Conklin et al., 2015	0-post ↑* ; *p* = .02; *d* = .61
		[3] Conklin et al., 2017	0-post ↑* ; *p* = .015 post-6 ↑ ; *p* = .306
Reading fluency	Woodcock Johnson III, reading fluency	**[3]** Conklin et al., 2015	0-post ↑ ; *p* = .184; *d* = .34
		[3] Conklin et al., 2017	0-post ↑ ; *p* = .193 post-6 ↑ *; p* = .521
Math fluency	Woodcock Johnson III, math fluency	**[3]** Conklin et al., 2015	0-post ↑ ; *p* = .620; *d* = .13
		[3] Conklin et al., 2017	0-post ↑ ; *p* = .710 post-6 ↓ *; p* = .395
General executive functioning	CPRS-3, executive functioning; *parent-rating*	**[3]** Conklin et al. 2015	0-post ↑* ; *p* = .002; *d* = .84
		[3] Conklin et al., 2017	0-post ↑* ; *p* = .01 post-6 ↑ *; p* = .618

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Table 2 *(continued)*

Metacognition	BRIEF, metacognitive index; *parent-rating*	**[3]** Conklin et al., 2015	0-post ↑ ; p = .071; d = .47
		[3] Conklin et al., 2017	0-post ↑ ; p = .111 post-6 ↑ *;* p = .654
Hyperactivity	CPRS-R, hyperactivity; *parent-rating*	**[2]** Kerr et al., 2015	0-post ↑ ; *not reported*
ADHD symptoms	CPRS-R, ADHD symptoms; *parent-rating*	**[2]** Kerr et al., 2015	0-post ↑ ; n*ot reported*
Learning problems	CPRS-3, Learning problems; *parent-rating*	**[1]** Hardy et al., 2013	0-post ↑*; p = .05; d = .80 0-3 ↑; p = .73; d = .38

Note. All tasks/questionnaires were administered to/answered by children, unless otherwise specified; Results column: 0-post and 0-3 indicate the comparison of baseline to post-intervention and 3-months follow-up scores; post-3 and post-6 indicate the comparison of the post-intervention score to a 3- or 6-months follow-up score; * indicates a statistically significant ($p \leq .05$) interaction effect (time x group); ↑ indicates an improvement/benefit for the intervention group; ↓ indicates a decline for the intervention group; = indicates no change of scores for the intervention group. Effect sizes were considered small if $d < 0.5$, medium if $d < 0.8$ and large if $d \geq 0.8$.

Table 3

Coping interventions – study characteristic

Study	Authors	Intervention	Sample	Analyses
5	Ambrosino et al., 2008 [a]	CST; 6 weeks; FtF, g; Active CTRL: General Education	T1D; 8-12 years; N = 87 + parents	Per-protocol; mixed-model repeated measures ANOVA
5	Grey et al., 2009 [a]	CST; 6 weeks; FtF, g; Active CTRL: General Education	T1D; 8-12 years; N = 82 + parents	Intent-to-treat; random coefficient regression analysis, adjusted for duration of diabetes, sex, treatment modality, parental income, controlled for differences at baseline + Pearson correlation coefficients [b]
6	Whittemore et al., 2012 [c]	Teencope; 5 weeks; o, i; Active CTRL: Managing Diabetes	T1D; 11-14 years; N = 320	Intent-to-treat; Mixed-effects linear regression models, controlled for intervention site + generalized estimating equations methods
6	Grey et al., 2013 [c]	Teencope; 5 weeks; o, i; Active CTRL: Managing Diabetes	T1D; 11-14 years; N = 320	Intent-to-treat; Mixed-effects linear regression, controlled for sex, age, race/ethnicity, disease duration, income, therapy type, intervention site [d]

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Table 3 *(continued)*

6	Jaser et al., 2014 [c]	Teencope; 5 weeks; o, i; Active CTRL: Managing Diabetes	T1D; 11-14 years; N = 320	Based on analyses in Grey et al., 2013: Mixed-effects model for each group separately, controlling for the variability of cross-sectional correlations between the mediator and outcome over time as well as the demographic covariates
7	Guo et al., 2020	CST; 2 days; FtF, g; tau CTRL	T1D; 8-12 years; N = 40 [e]	Per-protocol; Generalized estimating equation for repeated measures
8	Schatz et al., 2015	CBT-CST; 8 weeks; FtF + o, i; Waitlist CTRL	Sickle cell disease; 8-21 years; N = 46	Per-protocol; mixed-factor repeated measures MANOVA + multilevel modeling for pain-diaries
9	Scholten et al., 2013	Op Koers CBT; 6 weeks; FtF, g; Waitlist CTRL	*Diverse*; 7-18 years; N = 194	Intention-to-treat; mixed-model procedure with full-maximum likelihood estimation
10	Pulgaron et al., 2010	PAC-T; 1 week; FtF, g; tau CTRL	Asthma; 7-14 years; N = 50/48/41 [f]	*Not reported*; Mann-Whitney U test + ANOVA [g]

Note. Intervention column: name of intervention: CST = Coping Skills Training, Teencope = online version of Coping Skills Training, PAC-T=Problems and Answers have Consequences-now Try it! (problem-solving education intervention), Op Koers CBT=psychosocial group intervention based on cognitive-behavioral training methods; duration of the intervention program; intervention form: FtF = face-to-face, o = online; g = group, i = individual; control condition: CTRL = control, tau = treatment as usual. Sample column: Chronic physical condition: T1D = Type 1 Diabetes; age range of participants; N=number of participants included in statistical analyses. Analyses column: intent-to-treat/per-

protocol: while an intent-to-treat-analysis aims at preserving the original randomization to avoid bias due to exclusion of participants, a per-protocol analysis aims at identifying a treatment effect which would occur under optimal conditions. Thus, the first includes all participants as originally allocated after randomization, and the latter includes only participants who completed treatment.

[a] Ambrosino et al., 2008 and Grey et al., 2009 refer to the same study with the same sample. Ambrosino et al. (2008) reported short-term effects, Grey et al. (2009) reported long-term effects. Grey et al. (2009) reported statistical results in the text and tables, but p-values differ between the latter. In Table 4 we report results from the tables.
[b] Pearson correlations were used for mediation analyses but statistical results including coping processes as potential mediators were not significant and not reported in the study.
[c] Whittemore et al., 2012, Grey et al., 2013, and Jaser et al., 2014 refer to the same study with the same sample. Whittemore et al., 2012 reported short-term effects, Grey et al., 2013 reported long-term effects, and Jaser et al., 2014 reported the results of mediation analyses. Statistical results in the articles by Whittemore et al. (2012), Grey et al. (2013) and Jaser et al. (2014) were reported in the text/graphs/tables. The results in the different parts (text, graphs, tables) did not always match but did not influence the interpretation of the direction of effects.
[d] Grey et al. (2013) also compared participants who participated in one program vs. participants who participated in both programs (but did not report results for coping processes).
[e] The study included participants aged 8-20 years (N (analyzed)=100). In Table 4 will be reported the results referring to participants aged 8-12 years.
[f] Number of participants randomized: N = 50; Number of participants who completed post-test evaluation: N = 48 or N = 49 (different numbers reported in text and flow chart); Number of participants who completed follow-up evaluation: N=41 or N=42 (different numbers reported in text and flow chart). It is not clear how many participants were included in analyses.
[g] Mann-Whitney U test for treatment effect (interaction of group and time). ANOVA analyses with Wilcoxon effect sizes for exploratory time effect analyses.

Table 4

Coping interventions – results coping variables

Domain evaluated	Task/Scale	Study	Effect of intervention	Time/group-effects
General coping	CCSS, Negative coping style	[7] Guo et al., 2020	0-6-12 *not reported; p* = .855	*Group effect:* 0-6-12 *not reported; p* = .06
	CCSS, Positive coping style	[7] Guo et al., 2020	0-6-12 *not reported; p* = .210	*Group effect*: 0-6-12: ↑* *(higher scores for intervention group)*; *p*<.001 [a]
	CSCY, Probsol	[10] Pulgaron et al., 2010	0-post =; *p not reported*, *d*=.03 0-post-fu [b] ↑; *p not reported; d*.=02	*Time effect:* 0-post ↑* *(improvement for both groups; p*=.001, *d*=.40 *Time effect:* 0-fu [b] ↑* (*improvement for both groups*; *p*=.002, *d*=.47
Disease-related coping	QOpKoers, Information seeking	[9] Scholten et al., 2013	0-6-12 ↑* *(more improvement for parent-child intervention compared to control group); p* = .046; *d* = .03 [c]	*Time effect:* 0-6-12 ↑* *(improvement for all three groups)*; *p*<.001; *d* = .88
	QOpKoers, Relaxation	[9] Scholten et al., 2013	*Not significant + not reported*	*Time effect:* 0-6-12 ↑*; *p*<.001; *d* = .34
	QOpKoers, Medical compliance	[9] Scholten et al., 2013	*Not significant + not reported*	*Time effect:* 0-6-12 ↑*; *p*<.000; *d* = .74

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	QOpKoers, Social competences	[9] Scholten et al., 2013	0-6-12 ↑* *(more improvement for parent-child intervention compared to control group); p* = .048; *d* = .31	*Time effect:* 0-6-12 ↑*; *p*=.001; *d* = .52
	QOpKoers, Positive thinking	[9] Scholten et al., 2013	0-6-12 ↑* *(more improvement for parent-child intervention compared to control group); p* = .045; *d* = .22	*Time effect:* 0-6-12 ↑*; *p*<.000, *d*=.50
Diabetes specific coping	IC-IDDM, Hard/Difficult	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effect:* 0-1-3 ↑ *(improvement for both groups)*; *p* = .06; d=.25
		[5] Grey et al. (2009)	0-1-3-6-12 ↑ *(improvement for both groups); p = .911*	*Time effect:* 0-1-3-6-12 ↑* *(improvement for both groups)*; *p*=.002
	IC-IDDM, Hard/Difficult; *parent-rating for themselves*	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effects:* 0-1-3 ↑* *(improvement for both groups)*; *p*=.00; *d*=.29
	IC-IDDM, Upsetting	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effect:* 0-1-3 ↑* *(improvement for both groups)*; *p*=.05; *d*=.18
		[5] Grey et al. (2009)	0-1-3-6-12 ↑ *(improvement for both groups); p = .448*	*Time effect:* 0-1-3-6-12 ↑* *(improvement for both groups)*; *p*=.006

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IC-IDDM, Upsetting; *parent-rating for themselves*	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effect:* 0-1-3 ↑ *(improvement for both groups)*; *p*=.07; *d*=.21
RSQ, primary control coping	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Time effects: intervention group:* 0-3-6 ↑; *p* = .06*; control group:* 0-3-6 ↑; *p* = .056
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .30	Time effects: *intervention group:* 0-3-6-12 * *descriptives not reported; p*<.01; *control group:* 0-3-6-12 * *descriptives not reported; p*<.02
	[6] Jaser et al. (2014)	*Significant mediator of intervention effect on QoL: p* < .0001 *Not significant as a mediator of treatment effects on HbA1c: p* < .2	
RSQ, Secondary control coping	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Not reported*
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .44	*Time effects*: *intervention group*: 0-3-6-12 * *descriptives not reported; p*<.01; *control group:* 0-3-6-12 * *descriptives not reported*; *p*<.01
	[6] Jaser et al. (2014)	*Significant mediator of intervention effect on QoL: p*<.0001 *Not significant as a mediator of treatment effects on HbA1c: p* < .32	
RSQ, Disengagement	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Not reported*

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		[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; p = .23	*Time effects: intervention group*: 0-3-6-12 * *descriptives not reported*; p<.01; *control group:* 0-3-6-12 * *descriptives not reported*: p<.01
		[6] Jaser et al. (2014)	*Not significant as a mediator of treatment effects on QoL: p* < .13 *Not significant as a mediator of treatment effects on HbA1c: p* < .29	
	RSQ, Stress reactivity	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Not reported*
		[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; p = .81	*Time effects: intervention group:* 0-3-6-12 * *descriptives not reported*: p<.01; *control group*: 0-3-6-12 * *descriptives not reported* ;p<.01
		[6] Jaser et al. (2014)	*Significant mediator of intervention effect on QoL: p*<.0001 *Not significant as a mediator of treatment effects on HbA1c: p* <. 68	
Sickle-Cell-Disease-specific coping	CSQ-SCD, Coping attempts	[8] Schatz et al., 2015	0-2 ↑*; p=.032; η^2=.10	*Time effect:* 0-2 ↑* *(improvement only for intervention group)*; p = .041; η^2 = .091
	CSQ-SCD, Negative thinking	[8] Schatz et al., 2015	0-2 ↑ *(improvement for both groups)*; *p not reported;* η^2= .017	*Time effect:* 0-2 ↑ *(improvement for both groups)*; p = .085; η^2 = .066 *Group effect:* 0-2 ↑; p = .545; η^2 = .008

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	CSQ-SCD, Passive adherence	[8] Schatz et al., 2015	0-2 ↑ *(improvement for both groups)*; p = .801*;* η^2=.001	*Time effect:* 0-2 ↑ (*improvement for both groups)*; p = .298; η^2 = .025 *Group effect:* 0-2 ↑; p = .341; η^2 = .021
	CSQ-SCD, Pain controllability	[8] Schatz et al., 2015	0-2 ↑* p=.029; η^2 = .103	*Time effect:* 0-2 ↑* *(improvement only for intervention group; p*=.001; η^2=.237 *Group effect:* 0-2 ↑; p = .023; η^2 = .113
Pain-diary and coping skill use [d]	Pain intensity x self-reported coping skill use	[8] Schatz et al., 2015	*Day 0 – Day 1:* = *;* p = .546	/
	Pain intensity x use of coping skill exercises on smartphones	[8] Schatz et al., 2015	*Day 0 – Day 1*: ↑*; p = .048	/
	Same-day activity x self-reported coping skill use	[8] Schatz et al., 2015	*Day 0 – Day 1:* = *;* p = .119	/
	Pain intensity x use of coping skill exercises on smartphones	[8] Schatz et al., 2015	*Day 0 – Day 1:* = *;* p = .563	/

Note. All tasks/questionnaires were administered to/answered by children unless otherwise specified. Task/Scale column: CCSS = Children's Coping Strategies Scale; CSCY = Coping Scale for Children and Youth (Probsol = Problem-Solving subscale); QOKoers = Questionnaire OpKoers for children; IC-IDDM = Issues in Coping with Insulin-Dependant Diabetes Mellitus-Child scale; RSQ = Responses to Stress Questionnaire; CSQ-SCD = Coping Strategies Questionnaire for Sickle Cell Disease; Effects of intervention/Time-/Group-effects column: 0-… indicates the comparison of baseline to post-intervention or follow-up scores (1, 2, 3, 6, or 12 months), ↑/↓/= indicates a benefit/a decline/no change for the intervention group unless otherwise specified.

[a] The authors reported: « When data were analyzed by age group, there were significant improvements in the primary outcomes of positive coping and self-efficacy ($p < .05$) and in the secondary outcomes of diabetes self-management and quality of life ($p < .05$) in school-aged children who participated in the intervention group compared with school-aged children in the control group. » The authors did not report descriptive statistics or comparisons at baseline. It is unclear if differences between groups existed at baseline.
[b] Follow-up evaluation time point: *M*= 138 days, *SD* = 48, range = 3–7 months
[c] It is not clear if the reported result corresponds to an interaction effect (time x group) or to a time effect.
[d] Evaluation of the effect of coping skill use and smartphone coping skills exercises on next-day pain intensity/same-day activities reported by participants in daily diaries.

Table 5
Coping interventions – results for other variables

Task/Scale	Study	Effect of intervention	Time/group-effects
		Pediatric quality of life	
Quality of life scale for Children and Adolescents	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .50	*Group effect*: 0-6-12 ↑* *(more benefits for the intervention group)*; *p*=.016 [a]
Social-competence, Miami QoL	[10] Pulgaron et al., 2010	0-post =; *p-value not reported*; *d* = .12 0-fu [b] ↑; *p value not reported; d* = -.62	*Time effect:* 0-post ↑; *p-value not reported*; *d* = .06 *Time effect:* 0-fu =; *p value not reported; d* = -.10
Self-competence, Miami QoL	[10] Pulgaron et al., 2010	0-post =; *p-value not reported*, *d* = .24 0-fu =; *p-value not reported; d* = -.36	*Time effect:* 0-post ↑; *p-value not reported*; *d* = .10 *Time effect:* 0-fu ↓; *p value not reported; d* = -.42
Social-competence, Miami QoL *parent-rating for their child*	[10] Pulgaron et al., 2010	0-fu ↓*; p-value not reported*; *d* = -.29	*Time effect:* 0-fu ↓; *p-value not reported; d* = .30
Self-competence, Miami QoL *parent-rating for their child*	[10] Pulgaron et al., 2010	0-fu ↑; *p-value not reported*; *d* = -.34	*Time effect:* 0-fu =↓; *p-value not reported; d* = -.03
PedsQL, global	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Time effect:* 0-3-6 ↑* *(improvement for both groups)*; *p*<.05

	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported; p* = .42	*Time effect :* 0-3-6-12 ↑* *(improvement for both groups)*; *p*<.01 *Group effect:* 0-3-6-12 *descriptives not reported*; *p* = .22
	[6] Jaser et al. (2014)	/	
		Diabetes-related quality of life	
PedsQL, diabetes-specific	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Time effect: intervention group: not significant + not reported; control group:* 0-3-6: ↑*; *p*<.001
DQOL, Satisfaction	[5] Ambrosino et al. (2008)	0-1-3 ↑; *p* = .07*; d*=.019	/
	[5] Grey et al. (2009)	0-1-3-6-12 *descriptives not reported*; *p* = .758	*Time effect:* 0-1-3-6-12 *descriptives not reported*; *p* = .188
DQOL, Worry	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effect:* 0-1-3 ↑* *(improvement only for the intervention group)*; *p*=.0359; *d*=.23
	[5] Grey et al. (2009)	0-1-3-6-12 *descriptives not reported*; *p* = .08	*Time effect:* 0-1-3-6-12 ↑* *(improvement for both groups)*; *p*=.013

DQOL, Impact	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effect:* 0-1-3 ↑* *(improvement for both groups)*; *p*=.03; *d*=.22
	[5] Grey et al. (2009)	0-1-3-6-12 *descriptives not reported*; *p* = .957	*Time effect:* 0-1-3-6-12 *descriptives not reported*; *p* = .054
		Self-efficacy	
SED, General	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effect*: 0-1-3 ↑* *(improvement for both groups)*; *p*=.00; *d*=.32
SED, Medical	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Not significant + not reported*
SED, Diabetes	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effects:* 0-1-3 ↑* *(improvement for both groups)*; *p*=.00; *d*=.31
	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Time effects:* 0-3-6 ↑* *(improvement for both groups)*; *p*<.001
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .13	*Time effects*: *intervention group:* 0-3-6-12 ↑*; *p*<.01, *control group:* 0-3-6-12 ↑*; *p*<.01

	[6] Jaser et al. (2014)	Mediator of intervention effect on QoL: *p* = .0022 *Not significant as a mediator of treatment effects on HbA1c.*	
GSE (general self-efficacy scale)	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .504	*Group effect*: 0-6-12 ↑* *(more benefits for the intervention group)*; *p*=.017
		Diabetes self-management	
SMOD, Collaboration	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Time effects:* 0-3-6-12 ↑* *(improvement of both groups);* p<.01 [c]
	[6] Grey et al. (2013)	0-3-6-12 ↑; *p* = .68	*Time effects: intervention group:* 0-3-6-12 ↑*; *p* < .01; *control group:* 0-3-6-12 ↑*; *p* < .01
	[6] Jaser et al. (2014)	*Not significant as a mediator of treatment effects on QoL/HbA1c.*	
	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .166	*Group effect*: *descriptives not reported; p* = .078
SMOD, Activities	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Not significant + not reported*

	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .68	*Time effects: intervention group:* 0-3-6-12 *descriptives not reported*; *p* = .37; *control group:* 0-3-6-12 *descriptives not reported*; *p* = .14
	[6] Jaser et al. (2014)	*Not significant as a mediator of treatment effects on QoL/HbA1c.*	
	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .543	*Group effect*: *descriptives not reported; p* = .071
SMOD, Problem solving	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Not significant + not reported*
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .46	*Time effects:* 0-3-6-12: *intervention group:* ↑*; *p*=.03; *control group:* ↑*; *p*<.01
	[6] Jaser et al. (2014)	*Not significant as a mediator of treatment effects on QoL/HbA1c.*	
	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .171	*Group effect:* 0-6-12 ↑* *(more benefits for the intervention group)*; *p*=.007

SMOD, Communication	[6] Whittemoret al. (2012)	*Not significant + not reported*	*Not significant + not reported*
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .28	*Time effects:* 0-3-6-12: *intervention group:* ↑* *p*=.04; *control group: descriptives not reported; p* = .62
	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .399	*Group effect*: *descriptives not reported; p* = .20
SMOD, Goals	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Not significant + not reported*
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .63	*Time effects:* 0-3-6-12: *intervention group:* ↑*; *p*<.01; control group: ↑*; *p*<.03
	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .953	*Group effect:* 0-6-12 ↑* *(more benefits for the intervention group)*; *p*=.001
		Social competence	
SPPA, social acceptance	[6] Whittemore et al. (2012)	0-3-6: =* *(improvement for control group only)*, *p*=.013	*Time effects: intervention group: not significant + not reported; control group:* 0-3-6 ↑*; *p*<.001

	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .12	*Time effects:* 0-3-6-12: *intervention group:* ↑*, *p*<.01; *control group:* ↑*, *p*<.01
	[6] Jaser et al. (2014)	*Not significant as a mediator of treatment effects on QoL/HbA1c.*	
		Depression	
CDI	[5] Grey et al. (2009)	0-1-3-6-12 *descriptives not reported*; *p* = .574	*Time effect:* 0-1-3-6-12 ↑* *(improvement for both groups)*; *p*=.001
	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Not significant + not reported*
CES-D; *parent-rating for themselves*	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Not significant + not reported*
		Psychosocial problems	
Internalizing problems	[9] Scholten et al., 2013	0-6-12: *not significant; χ2*(3)=1.23, *p*=.75 [d]	*Time effects:* 0-6-12: ↑*; *p*<.001, *d*=.95

Internalizing problems, *parent-reports*	[9] Scholten et al., 2013	0-6-12 : ↑*; *p* = .025	*Time effects:* 0-6-12: ↑*; *p*=.005; *d*=.31
Externalizing problems	[9] Scholten et al., 2013	0-6-12 ↑* *(more improvement for parent-child intervention compared to child-only group); p* = .046; *d* = .027; *d* 0.42 [e]	*Time effects:* 0-6-12: ↑*; *p*=.001; *d*=.56
Externalizing problems, *parent-reports*	[9] Scholten et al., 2013	0-6-12: n*ot significant, χ2* (3)=2.28, *p*=.39 [d]	*Time effects:* 0-6-12: ↑*; *p*=.000; *d*=.61
		Stress	
PSS	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Time effects*: *intervention group:* 0-3-6 ↑*; *p* < .05; *control group: not significant + not reported*
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .81	*Time effects: intervention group:* 0-3-6-12: ↑*, *p*=.04; *control group:* 0-3-6-12: ↑*, *p*=.04
	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .330	*Group effect*: *descriptives not reported; p* = .890
		Family adaptability and cohesion	

DFBS, Guidance & Control	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Not significant + not reported*
	[5] Grey et al. (2009)	0-1-3-6-12 *descriptives not reported*; *p* = .867	*Time effects:* 0-1-3-6-12 ↑* *(improvement for both groups)*; *p*=.001
DFBS, Warmth & Caring	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Not significant + not reported*
	[5] Grey et al. (2009)	0-1-3-6-12 *descriptives not reported*; *p* = .821	*Time effects:* 0-1-3-6-12 *descriptives not reported*; *p* = .906
DFCS, Family conflict	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Not significant + not reported*
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .02	*Time effects:* intervention group: 0-3-6-12 *descriptives not reported; p* = .04; *control group*: *descriptives not reported;* 0-3-6-12; *p* = .03
	[6] Jaser et al. (2014)	*Not significant as a mediator of treatment effects on QoL/HbA1c.*	
Diabetes responsibility and conflict scale			

DRCS, Responsibility distribution; *parent-rating*	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effects:* 0-1-3: ↑* *(improvement for both groups); p*<.00; *d*=.28
DRCS, Conflict; *parent-rating*	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Not significant + not reported*
FACES-II, Adaptability; *parent-rating*	[5] Ambrosino et al. (2008)	0-1-3 ↑* ; *p* = .01; *d* = .28	/
FACES-II, Cohesion; *parent-rating*	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effects:* 0-1-3 ↑*: *(improvement for both groups)*; *p* = .02; *d* = .12
FACES-II, Cohesion; *parent-rating*	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effects:* 0-1-3 ↑*: *(improvement for both groups)*; *p* = .02; *d* = .12
	[10] Pulgaron et al. 2010	0-post =; *p-value not reported*, *d* = 0 0-fu ↑; *p* = .077*; d* = .43	*Time effects:* 0-post =; *p* = .097, *d* = -.011 0-fu ↑**(improvement for both groups)*; *p* ≤ .001*; d* = .82
Glycated haemoglobin			

DCA2000, HBA1c	[5] Ambrosino et al. (2008)	*Not significant + not reported*	*Time effects:* 0-1-3 ↓* *(decline for both groups)*; *p*=.002; *d*=.20
	[5] Grey et al. (2009)	0-1-3-6-12 *descriptives not reported*; *p* = .265	*Time effects*: 0-1-3-6-12: ↓* *(decline for both groups)*; *p*=.001
	[6] Whittemore et al. (2012)	*Not significant + not reported*	*Time effects: intervention group: not significant + not reported; control group:* 0-3-6 ↓*; *p* = .014
	[6] Grey et al. (2013)	0-3-6-12 *descriptives not reported*; *p* = .65	*Time effects:* 0-3-6-12 ↓* (*decline for both groups)*; *p*=.05 *Group effects:* 0-3-6-12; *p = .*28
	[6] Jaser et al. (2014)	/	
Not reported	[7] Guo et al., 2020	0-6-12: *descriptives not reported; p* = .200	*Group effect*: *descriptives not reported; p* = .484

Note. All tasks/questionnaires were administered to/answered by children unless otherwise specified. Task/Scale column: Miami QoL = Miami Pediatric Quality of Life Questionnaire; PedsQL = Pediatric QOL Inventory for children with health conditions; DQOL = Quality of Life Scale for Youth; SED=Self-Efficacy for Diabetes scale; GSE = General Self-Efficacy scale; SMOD = Self-Management of Type 1 Diabetes in Adolescence

scale; SPPA = Self-Perception Profile for Adolescents; CDI = Children's Depression Inventory; CES-D = Center for Epidemiologic Depression Scale; PSS = Perceived Stress Scale; DFBS = Diabetes Family Behavior Scale; DRCS = Diabetes Responsibility and Conflict Scale; FACES-II = Family Adaptability and Cohesion Scale; Effects of intervention/Time-/Group-effects: 0-… indicates the comparison of baseline to post-intervention or follow-up scores (1, 2, 3, 6, or 12 months), ↑/↓/= indicates a benefit/a decline/no change for the intervention group unless otherwise specified.

[a] The authors reported: « When data were analyzed by age group, there were significant improvements in the primary outcomes of positive coping and self-efficacy ($p < .05$) and in the secondary outcomes of diabetes self-management and quality of life ($p < .05$) in school-aged children who participated in the intervention group compared with school-aged children in the control group. » The authors did not report descriptive statistics or comparisons at baseline. It is unclear if differences between groups existed at baseline.

[b] Follow-up evaluation time point: *M*= 138 days, *SD* = 48, range = 3–7 months

[c] Corresponds to a decrease in collaboration with parents which is considered a benefit during adolescence.

[d] Model not significantly better than a model without interaction effect.

[e] It is not clear if the reported result corresponds to an interaction effect (time x group) or to a time effect.

Table 6
Methodological issues

Study	Controlled for baseline differences	Correction for multiple comparison	Clear statistics and results reporting [a]	Effect sizes reported
[**1**] Hardy et al., 2013	Yes	No	Yes	Yes
[2] Kerr et al., 2015	Yes	Yes	Yes	Yes
[3] Conklin et al., 2015	Yes	No	Yes	Yes
[3] Conklin et al., 2017	Yes	No	No (S)	Yes
[4] Jordan et al., 2020	Yes	No	Yes	No
[5] Ambrosino et al., 2008	Yes	No	No (S+R)	Yes
[5] Grey et al., 2009	Yes	No	No	No
[6] Whittemore et al., 2012	No	No	No	No
[6] Grey et al., 2013	No	No	No	No
[6] Jaser et al., 2014	No	No	No	No
[7] Guo et al., 2020	No	No	Yes	No
[8] Schatz et al., 2015	Yes	No	Yes	No
[9] Scholten et al., 2013	Yes	No	No (S)	Yes

[10] Pulgaron et al., 2010	Yes	No	Yes	Yes

[a] S: problem with statistics; R: problem with results reporting

Appendix A

Description of the Cogmed intervention

The Cogmed program includes eight different exercises (including visuo-spatial and verbal working memory tasks) which are presented as computer games. Exercises' difficulty levels adjust to the child's performance based on a trial-by-trial principle; the child's progression is tracked online. Motivational components such as verbal and visual feedback and encouragements are given automatically by the program during the training sessions. In addition, participants also received a weekly call from a trained coach who gives advice and feedback and motivates the participants. The original training includes a total of 25 training sessions (5 sessions of 30-45 minutes per week, for 5-7 weeks) but additional training sessions can be added if necessary.

Appendix B

Coping interventions

The Coping Skills Training (CST) was developed by Margaret Grey et al. (2000), (co-) author of several publications included in this systematic review based on the work by Forman (1993). The intervention is built on Bandura's social cognitive theory (Bandura, 1986) and a stress-adaptation model (Pollock, 1986) which helps to understand to which degree an individual adjusts, psychologically and physiologically, to stress related to living with a CPC. The training's objective is to help children with Type 1 Diabetes (T1D) to better deal with day-to-day problems that may arise as opposed to dealing with the management of T1D only, which is often the focus of traditional educational interventions for children with T1D. The idea is that repeatedly applying new skills (e.g., coping) can change behavior and enhance self-efficacy (Grey et al., 2009). The training focuses on inappropriate or non-constructive coping strategies, and retrained behaviors. Six different competences are trained: communication, social problem solving, recognition of associations between thoughts, feelings, and actions, guided self-dialogue, stress management, and conflict resolution. CST was designed as a family-based program. Small groups of children meet once a week for six weeks for 1.5 hours. Parents meet at the same time but separately. After the separate group sessions, children and parents meet, and discuss their session. Sessions are facilitated by a mental health professional. Teencope is an internet-based form of CST. It shows diverse, digitally created game characters with T1D in challenging situations who present ways of solving problems, and the consequences of different decisions taken. The program is interactive and encourages children to test different coping styles in their daily life. Experiences can be shared with peers on a discussion board which is moderated by a health professional. Teencope is delivered to each child on a computer and does not involve parents. It includes one session of

approximately 30 minutes per week, for five weeks (Whittemore et al., 2010). The control group in the two studies followed an educational program with the same duration as the CST/Teencope intervention. It was based on standards of care for diabetes management focusing on improving participants' capacities to make diabetes-related decisions. Group education (GE) was provided to participants in one study (study 5: Ambrosino et al., 2008; Grey et al., 2009), and was facilitated by a nurse. GE focuses directly on T1D-related topics such as intensive insulin regiments, nutrition, sports and sick days, updates, and technology. While the CST intervention focuses on a broader social context in which diabetes-related situations occur, GE focuses on the diabetes-related issues themselves. An equivalent control (Managing Diabetes) was provided to participants in the second study (study 6: Grey et al., 2013; Jaser et al., 2014; Whittemore et al., 2012). It is internet-based and includes diabetes educational components and problem-solving exercises which were closely related to diabetes management (same topics as for GE). The Managing Diabetes intervention was delivered individually to each child on a computer. The control intervention did not include any interaction with other participants. Both studies included participants with T1D and evaluated coping skills, quality of life and other psychological variables such as self-efficacy or self-management. Only Ambrosino et al. (2008; study 5) included parent-reported measures.

Guo et al. (2020; study 7) adapted the original CST program to the Chinese culture and implemented seven CST sessions (60-90 minutes) in a two-day camp for children with T1D. One diabetes education session on T1D-related subjects was added by the authors. After the camp, five phone call sessions were scheduled over the next five months, to ensure the strengthening and supervision of the learned coping skills in daily life. The intervention and the passive control group received standard care including a quarterly appointment at the

clinic and contact with a specialist in endocrinology, in nutrition, rehabilitation, psychology, ophthalmology, and/or diabetes education.

Schatz et al. (2015; study 8) implemented a “CBT Coping Skills Training” (CBT-CST) for children with sickle cell disease (SCD). It was designed based on the work by Gil et al. (1996, 1997) and includes a definition and explanation of how cognitive coping strategies can reduce pain, a description of each strategy (e.g., relaxation, pleasant imagery, reinterpreting pain sensations, calming self-statements) and their practice. A single face-to-face intervention of 45 to 60 minutes was scheduled with each child (and a parent if desired). During the session, a psychologist explained how CBT methods could help to deal with pain, gave some psychoeducation about pain, gate control theory, and coping, and explained and demonstrated deep breathing, guided imagery, distraction, and progressive muscle relaxation exercises. After the single session, children were provided with a smartphone on which an application was installed. The application included coping strategy exercises (deep breathing, progressive muscle relaxation, and guided imagery) accessible through audio files one of the coauthors designed based on traditional CBT scripts. Daily pain and activity were also evaluated on smartphones. Participants were encouraged to practice skills daily. Families were contacted weekly by telephone to address potential difficulties. The control group (waitlist) received standard care for SCD.

Scholten et al. (2013; study 9) developed a psychosocial intervention that teaches cognitive-behavorial skills, specific to children with CPC (various CPCs included: T1D, autoimmune disease, kidney disease, IBD, asthma, congenital disease and others). The intervention for the children consisted of six group sessions of 90 minutes each, given by psychologists. Five different coping strategies were taught: seeking information about the

disease, relaxation, knowledge of self-management and medical compliance, social competence, and positive thinking. For a second group of children, parents participated parallelly in six 90-minutes sessions which consisted of information about how to reply sensitively to their child's needs and how to encourage the use of the learned coping skills. It was not specified if the waitlist control group received any alternative care.

Pulgaron et al. (2010; study 10) implemented a problem-solving intervention during a camp for children with persistent asthma. The intervention was designed based on problem-solving therapy techniques and divided into four main domains: 1) defining and formulating a problem, 2) generating alternative solutions, 3) deciding which solution to implement, based on the identification of consequences, and conducting a cost-benefit analysis, 4) implementing a solution and verifying whether it was successful. The intervention was called PAC-T (Problems and Answers have Consequences-now Try it!). Four sessions were conducted during which general and disease-specific problem-solving techniques were discussed and practiced. More specifically, sessions consisted of a group discussion, a solution generation process, a modeling of how to apply the PAC-T model, and role-plays. Educational materials with the taught problem-solving skills were also sent to the parents. While the intervention group received problem-solving intervention, the control group participated in a group session reflecting and discussing the day's activity. The camp participants, neither in the intervention nor in the control group, did not receive explicit educational care training on asthma.