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Review Article

# Effectiveness of CO-OP Approach for Children With Neurodevelopmental Disorders: A Systematic Review



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**KEYWORDS**
Children with disabilities;
Motor Skills Disorders;
Neurodevelopmental disorders;
Occupational therapy;
Rehabilitation

**Abstract** *Objective:* To examine the scientific evidence regarding the effectiveness of the Cognitive Orientation to Daily Occupational Performance (CO-OP) approach for children with neurodevelopmental disorders (NDDs).
*Data Sources:* Selected articles published between January 2001 and September 2020 and listed in CINAHL, MEDLINE, and PsycINFO on the EBSCO platform, or found searching with Scopus, Google Scholar, OTseekern Central Register of Controlled Trials in the Cochrane Library, WHO International Clinical Trials Registry Platform, Turning Research into Practice, and ProQuest Dissertations and Theses. An update was performed in March 2022.
*Study Selection:* Eligibility criteria included studies that assessed the effectiveness of the CO-OP approach on children (0-18 years) with NDDs. Unpublished results were excluded, as well as research published in a language other than English or French.
*Data Selection:* The first 2 authors independently reviewed the titles, abstracts, and full texts. Discrepancies were discussed and resolved by consensus. Included studies were quality appraised using the PEDro-P scale or using the risk of bias scale in N-of-1 trials (RoBiNT) according to experimental design.
*Data Synthesis:* Results were reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. Eighteen studies were initially included, with 2 additional studies

*List of abbreviations:* ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder; CO-OP, Cognitive Orientation to Daily Occupational Performance; DCD, developmental coordination disorder; DSM-5, Diagnostic and Statistical Manual of Mental Disorders 5th edition; ICF, International Classification of Functioning, Disability and Health; MABC, Movement Assessment Battery for Children; NDDs, neurodevelopmental disorders; NRCT, non-randomized controlled trial; RCT, randomized controlled trials; RoBiNT, risk of bias scale in N-of-1 trials; SCED, single-case experimental design.

Clinical Trial Registration: The review protocol was registered in the International Prospective Register of Systematic Reviews in PROSPERO (registration number: CRD42020166970) on November 22, 2020. An update was performed up until March 2022 using the same procedure.
Disclosures: Noémi Cantin and Emmanuel Madieu are certified CO-OP Instructors for International Cognitive Approaches Network (ICAN) and Noémi Cantin is in board of directors of ICAN. The other coauthors have no conflicts of interests to disclose.
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added in the update. Three reached evidence level III (15%), 10 reached level IV (70%), and 5 reached level V (15%). All data collected on the activity-participation domain showed a significant improvement. Group therapy sessions show promising results for the improvement of activities or participation, as well as psychosocial dimensions such as self-esteem.
*Conclusions:* The scientific evidence analyzed shows that the CO-OP approach has a positive effect on children with NDDs, particularly in regard to their activities and participation. Future experimental studies should be designed in ways that allow determining effect sizes. Group therapy sessions appear relevant but require further research.


The prevalence of neurodevelopmental disorders (NDDs) is estimated to be around 17% of children in the general population.[1] NDDs encompass a variety of disorders that start to manifest early on during a child's development. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5)[2] groups autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), and developmental coordination disorder (DCD), among others, in this category. Research has shown that the presence of a NDD affects children's functioning in many ways. While some authors note the effect of NDDs on daily activities,[3] others note the effect on other functional domains such as physical health,[4-6] self-efficacy,[7] and social participation.[7,8] It is well acknowledged that these different domains should be considered as a system where each element is interconnected.

## International Classification of Functioning, Disability and Health

The International Classification of Functioning, Disability and Health (ICF)[9] offers a terminology widely used to describe the functioning of people with health problems. Among other things, it enables the user to classify the effect of a disorder into conceptually related categories and to highlight the complexity of the interactions that lead to a person's functioning. While the first category, organic structures and functions, refers to structures and processes encompassed within a person such as memory or balance, the second category, activity and participation, refers to tasks carried out by a person and their realization in real-life situations. The third category, contextual and personal factors, includes physical and community elements that can affect functioning, as well as individual aspects such as age, sex, or self-efficacy.

Many authors recognize an increased effectiveness of activity and participation-focused approaches for children with NDD[10-14] compared with impairment-focused approaches.[15-17] This is partially due to the incompatibility between impairment-focused approaches and family priorities, as the therapist often sets goals without necessarily including the client.[18] Indeed, a client-centered approach that places the client's needs and active participation at the center of the therapeutic process is known to be essential to a successful intervention.[19]

For those reasons, over the past decades, researchers have asserted the need to move toward a paradigm consistent with new evidence, the current reality of therapists' practice settings, and the needs of children. A paradigm shift[20,21] in rehabilitation for children emerged in the 2000s. In this new paradigm, learning-based approaches are advocated to enable children to perform their activities that are meaningful to them, thus leading to an improvement in their daily functioning.

## The Cognitive Orientation to Daily Occupational Performance Approach

One such learning-based approach is the Cognitive Orientation to Daily Occupational Performance (CO-OP) approach,[22] recommended in the practice guidelines from the European Academy of Childhood Disability for children with DCD.[3] The main goals of the CO-OP approach are for children to develop new skills, learn cognitive strategies, apply learned skills and strategies to real-life situations, and transfer learned skills and strategies to other activities.[23] The CO-OP approach is child-focused, in that it is the child who identifies the objectives with the therapist and the child's involvement is essential throughout the intervention. The child gradually discovers cognitive strategies while using a global problem-solving strategy. In addition, the CO-OP approach actively involves the family and caregivers to promote practice opportunities and to support generalization.

Over the years, few literature syntheses were conducted on this approach. In 2016, a scoping review was performed to identify the nature and extent of the literature on the CO-OP approach.[24] A total of 27 studies were identified, as well as 2 protocols published between 2001 and 2015. Results show that 26 of the 27 articles reported positive outcomes in terms of measured motor activity acquisition. Scammell et al[24] highlighted the need to explore the effectiveness of the CO-OP approach with different populations, to examine proposed changes to the approach based on population groups and to conduct a quality systematic review.

In 2017, an integrative literature review was published to assess the effectiveness of the CO-OP approach when used solely in group therapy sessions with children with motor difficulties such as DCD.[25] Seven studies were identified and summarized both qualitatively and quantitatively. Results show a trend toward improvement in motor coordination and psychosocial dimensions, such as feelings of acceptance by one's peers or a sense of belonging in a group. The authors did note, however, that their conclusions were limited. In addition to the small number of studies identified, the authors highlighted the potential measurement bias due

to the lack of blind assessments. Thus, they concluded that the systematic review did not provide the evidence to support using the CO-OP approach in a group therapy setting as evidence-based practice, although they recognized that this delivery mode was promising.

While those 2 articles have synthesized some of the literature on the CO-OP approach, their focus has been either on a specific NDD or on a specific delivery mode. Furthermore, the authors have questioned the methodological quality of the articles reviewed, which suggests the need for an update with the latest studies available. Therefore, the goal of this study was to synthesize the updated evidence on the effectiveness of the CO-OP approach when used with children with different NDDs. In particular, this study aimed to document the effect of the approach in regard to the different ICF components, as well as the delivery mode (group or individual therapy sessions). Finally, by synthesizing the updated evidence on the approach, this study aimed to identify the remaining gaps and provide recommendations for future studies.

## Methods

Given the objectives of this study, a systematic review was selected as study design. Methods used in this review are consistent with recommendations from the Cochrane and Campbell collaborations,[26,27] and the methods and outcomes are reported in accordance with PRISMA guidelines.[28] In addition, the review protocol was registered in the International Prospective Register of Systematic Reviews PROSPERO (registration number: CRD42020166970) on November 22, 2020. An update was performed up until March 2022 using the same procedure.

### Search strategy

A systematic review of studies related to the CO-OP approach was undertaken to identify eligible, published, clinical research.[29] The search strategy, developed in consultation with a qualified librarian, targeted studies published between January 1, 2001, and September 1, 2020, for the primary search, along with an update up until March 5, 2022. The following bibliographic databases were searched, using on a strategy tailored to each database including appropriate syntax and terminology: (1) general and health-related databases (CINAHL, MEDLINE, and PsycINFO on the EBSCO platform, along with Scopus, Google Scholar, and OTseeker); (2) trial registers (Central Register of Controlled Trials in the Cochrane Library, WHO International Clinical Trials Registry Platform, Turning Research Into Practice); and (3) gray literature sources (ProQuest Dissertations and Theses). Finally, the bibliographic references of the retrieved articles were manually searched.

### Eligibility criteria

Articles that met the following eligibility criteria were included. First, the main objective of the reported research had to pertain to assessing the effect of the CO-OP approach on subjects' functioning as defined by the ICF, with the CO-OP approach delivered in an individual or group therapy sessions. Therefore, randomized controlled trials (RCTs), non-randomized controlled trials (NRCTs), 1-group designs, and single-case experimental designs (SCEDs) were included. Studies exploring the effectiveness of the intervention in specific population groups were included.[30] Second, only RCTs and NRCTs with comparative interventions (eg, inactive control intervention or alternative interventions) with an equivalent number of sessions were included. Finally, all participants had to be children up to 18 years of age with an NDD, as described in DSM-5[2] or earlier versions of the DSM. Therefore, studies exploring the effectiveness of the CO-OP approach in children with ADHD, ASD, DCD, or a learning disability were included. Ongoing studies with unpublished results or written in languages other than English or French were excluded.

### Study selection

All search results were imported into EndNote[a] and duplicates were removed. Initially, the first 2 authors independently reviewed the titles and abstracts to determine the eligibility of the study. Next, the texts were fully assessed to confirm eligibility and to select relevant studies. The reviewers corresponded with authors for further details when necessary to clarify whether the study was eligible or not. Discrepancies were discussed and resolved by consensus, and by involving a third author when necessary. Figure 1 provides details on the selection process for the studies.

### Assessing the quality of studies

The methodology of the RCT and NRCT studies was assessed using the PEDro-P scale.[31] The methodology of SCED studies was assessed using the risk of bias scale in N-of-1 trials (RoBiNT).[32,33] Data quality was assessed independently. The authors resolved score discrepancies by consensus. Studies were quality-ranked according to the Oxford Center for Evidence-Based Medicine[34] criteria for RCTs and the level of evidence for single-subject research designs[35] for SCEDs. The RoBINT scale algorithm[36] was used to map the single-subject research designs levels of evidence and the RoBINT levels. Studies could then be classified into 5 different levels, regardless of the design used for comparison. The methodological quality of single-arm designs and case studies was not assessed. Given the potential for biases with this kind of work, those studies were automatically classified as very low quality designs (level V).

### Data extraction and analysis

The authors independently extracted the data from included studies. Data were categorized according to background information (authors, year, and country), design, participant characteristics (diagnosis, age, and sex), intervention description (parameters, format, and frequency), results (reported results, measurement tools, and points in time) and conclusion. Studies' results were categorized according to ICF components, namely, body functions, activities, or participation, environmental factors, and individual factors. A descriptive approach was used to synthesize the data.

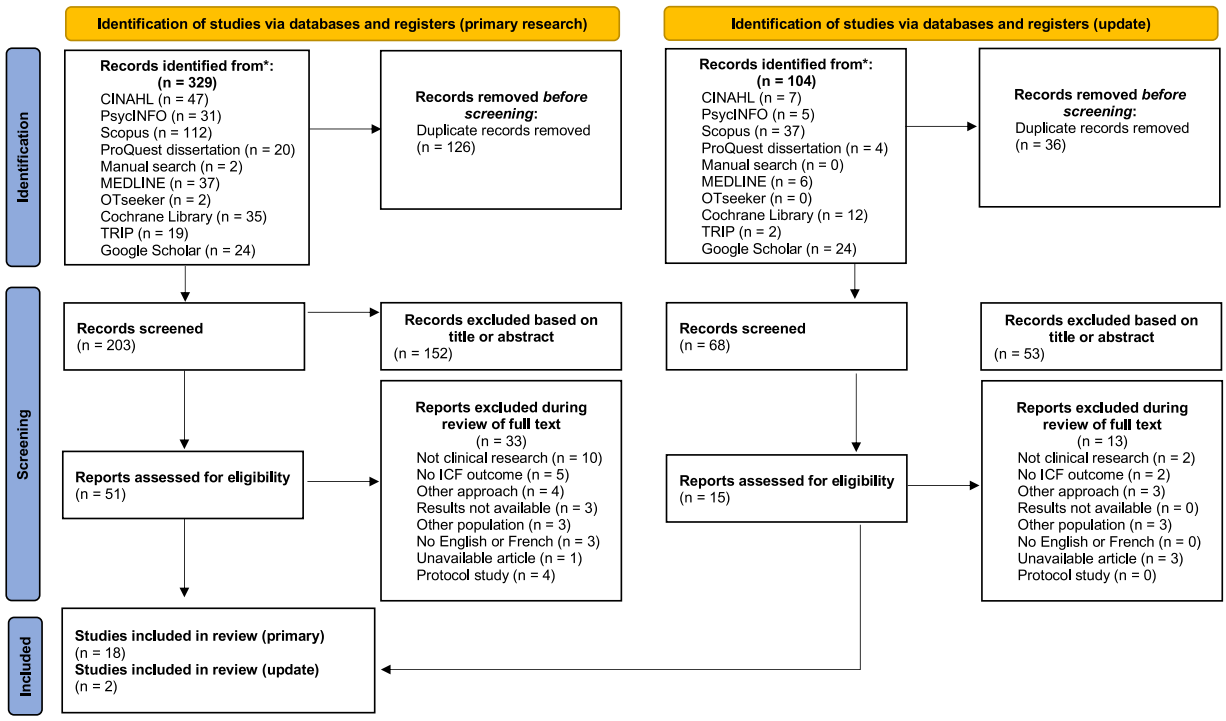


**Fig 1** Flowchart.

## Results

### Summary of selected studies

The initial search provided 433 different studies. The selection process led to the inclusion of 20 articles. Of those, 13 focused on DCD, 5 focused on ASD, 1 focused on ADHD, and 1 focused on learning disability. Of the 20 articles selected, 11 used the CO-OP approach in an individual format and 6 in group therapy sessions. Finally, 3 studies did not allow for a decision on the mode of intervention. Of the 20 articles selected, 11 included measures pertaining to body functions, 19 to activities or participation, and 12 considered contextual factors. In most of the cases, the selected studies measured 2 (12 studies) to 3 domains of the ICF (three studies). Only 1 study investigated a single domain. Table 1 summarizes the different elements of analysis, organizing studies according to year of publication to highlight changes over time.

### Measurement tools by outcome

Of the 11 studies that measured body functions, 5 used the Movement Assessment Battery for Children (MABC-1 or MABC-2), 4 used the Buininks-Osertesky Test of Motor Proficiency, and 3 used the Beery-Buktenica Developmental Test of Visual-Motor Integration (table 2).

Of the 19 studies that measured activities or participation, 18 used the Canadian Occupational Performance Measure, 11 used the Performance Quality Rating Scale, 3 used the Vineland Adaptative Behavior Scales, and 2 used the Goal Attainment Scaling or the Evaluation Tool for Children's Handwriting. The Assessment of Motor and Process Skills, the Children's Assessment of Participation and Enjoyment, the Children's Self-Perceptions and Adequacy in Predilection for Physical Activity, the Perceived Efficacy and Goal Setting System, the Participation and Environment Measure for Children and Youth, the Social Skills Rating Scale, and the Test of Grocery Shopping Skills were used in only 1 study (table 3).

Of the 12 studies considering the effect of the CO-OP approach on contextual factors, 6 reported what parents said after the intervention, 3 used a logbook or a similar tool, 2 used an interview, and 1 used the Self-Perception Profile for Children (table 4).

Only 6 studies reported effect sizes, 2 measured body functions, and 4 measured activities or participation. Four studies with an effect size focused on DCD, 1 focused on ADHD, and 1 focused on learning disability. As for the activities or participation domain, effect sizes noted were "moderate to large" for DCD, "moderately effective" for ADHD, and "moderate" for learning disability (table 2).

### Effect of CO-OP interventions on ICF components

Of the 11 studies that measured body functions, positive effects were found in 3 level III studies (moderate evidence) with control procedures, including 2 measuring motor functions and 1 visuospatial and executive functions. Positive effect were also reported in 2 level IV studies (low evidence) with control procedure, and 1 level IV study without a control procedure. However, 6 studies showed no improvement in body functions, including 3 level IV with control procedures on motor functions, 2 level IV without a control procedure, and 1 level V (very low evidence) without a control procedure. As for activities or participation, the 19 studies measuring this domain showed improvement. Of those studies, 3 were level III with control procedures, 11 were level IV, of which 7 had a control procedure, and 5 were level V,

**Table 1** Summary of studies (oldest to newest)

| | Disorder | Design | | Quality | | | | | Delivery Mode | Key Measurements | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | cp | wcp | I | II | III | IV | V | | Body Function | Activity Participation | Contextual Factors |
| Miller et al (2001)[29] | DCD | X | | | | | X | | Ind. | X | X | X |
| Ward and Rodger (2004)[57] | DCD | | X | | | | | X | Ind. | X | X | X |
| Chan et al (2007)[58] | DCD | | X | | | | X | | Group | X | X | |
| Rodger et al (2007)[59] | ASD | | X | | | | | X | Ind. | | X | X |
| Taylor et al (2007)[60] | DCD | X | | | | X | | | Ind. | | X | |
| Green et al (2008)*,[61] | DCD | X | | | | X | | | Group | X | | |
| Rodger et al (2008)[62] | ASD | | X | | | | | X | Ind. | | X | X |
| Phelan et al (2009)[68] | ASD | X | | | | | X | | Ind. | | X | X |
| Rodger and Brandenburg (2009)[63] | ASD | | X | | | | | X | Ind. | | X | X |
| Czmowski et al (2014)[64] | ASD | | X | | | | | X | Ind. | | X | X |
| Gharebaghy et al (2015)*,[65] | ADHD | X | | | | X | | | NA | X | X | |
| Zwicker et al (2015)[66] | DCD | | X | | | | X | | Group | | X | X |
| Capistran et al (2016)*,[67] | DCD | X | | | | | X | | Ind. | | X | X |
| Thornton et al (2016)[69] | DCD | X | | | | | X | | Group | X | X | X |
| Karunakaran (2017)*,[70] | Learning disorder | X | | | | | X | | NA | | X | |
| Anderson et al (2018)[71] | DCD | | X | | | | X | | Group | X | X | X |
| Johnson (2018)[72] | DCD | X | | | | | X | | NA | X | X | |
| Araùjo et al (2019)[73] | DCD | | X | | | | X | | Group | X | X | |
| Araùjo et al (2021)*,[74] | DCD | X | | | | X | | | Ind. | X | X | X |
| Izadi-Najafabadi et al (2021)*,[75] | DCD + ADHD | X | | | | X | | | Ind. | X | X | |

Abbreviations: cp, control procedure; Ind., individual; NA, delivery mode not available; wcp, without control procedure.

* Studies with effect sizes.

**Table 2** Summary of tools for outcomes in domain of body functions and structures

| | Body Structure Test | Executives Functions Tests | | Motion Capture | Motor Tests | | Visual Test |
|---|---|---|---|---|---|---|---|
| | MRI | FDT | ToL | VICON | BOTM | MABC 1 &2 | VMI |
| Miller et al (2001)[29] | | | | | ± | | + |
| Ward and Rodger (2004)[57] | | | | | | | = |
| Chan et al (2007)[58] | | | | | = | | |
| Rodger et al (2007)[59] | | | | | | | |
| Taylor et al (2007)[60] | | | | | | | |
| Green et al (2008)*,[61] | | | | | | + | |
| Rodger et al (2008)[62] | | | | | | | |
| Phelan et al (2009)[68] | | | | | | | |
| Rodger and Brandenburg (2009)[63] | | | | | | | |
| Czmowski et al (2014)[64] | | | | | | | |
| Gharebaghy et al (2015)*,[65] | | | | | + | | |
| Zwicker et al (2015)[66] | | | | | | | |
| Capistran et al (2016)*,[67] | | | | | | | |
| Thornton et al (2016)[69] | | | | + | | = | |
| Karunakaran (2017)*,[70] | | | | | | | |
| Anderson et al (2018)[71] | | | | | | ± | |
| Johnson (2018)[72] | | | | | | | + |
| Araùjo et al (2019)[73] | | | | | | = | |
| Araùjo et al (2021)*,[74] | | + | = | | | | |
| Izadi-Najafabadi et al (2021)*,[75] | + | | | | = | | |

Abbreviations: "+", improvement; "-", degradation; "±", mixed result; "=", stable result; BOTMP, Bruininks–Oseretsky Test of Motor Proficiency and Performance; FDT, Five Digits Test – Brazilian version; MRI, magnetic resonance imaging; ToL, Tower of London test; VICON, 3-dimensional motion analysis using camera Vicon MX system; VMI, Beery-Buktenica Developmental Test of Visual Motor Integration.

* Studies with effect sizes.

**Table 3** Summary of tools used for outcomes in domain of activity and participation

| | AMPS | CAPE | COPM | CSAPPA | ETCH-M | GAS | PEGS | PEM-CY | PQRS | SSRS | TOGSS | VABS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Miller et al (2001)[29] | | | + | | | | | | + | | | + |
| Ward and Rodger (2004)[57] | | | + | | | | | | | | | + |
| Chan et al (2007)[58] | + | | + | | | | | | | | | |
| Rodger et al (2007)[59] | | | | | | | | | | | | |
| Taylor et al (2007)[60] | | | + | | | | | | + | | | |
| Green et al (2008)*,[61] | | | | | | | | | | | | |
| Rodger et al (2008)[62] | | | + | | | | | | + | + | | |
| Phelan et al (2009)[68] | | | + | | | | | | + | | | |
| Rodger and Brandenburg (2009)[63] | | | + | | | | | | + | | | + |
| Czmowski et al (2014)[64] | | | + | | | | | | ± | | | |
| Gharebaghy et al (2015)*,[65] | | | + | | | + | | | | | | |
| Zwicker et al (2015)[66] | | = | + | = | | | = | | | | | |
| Capistran et al (2016)*,[67] | | | + | | | | | | + | | | |
| Thornton et al (2016)[69] | | | + | | + | + | | | | | | |
| Karunakaran (2017)*,[70] | | | + | | | | | | + | | + | |
| Anderson et al (2018)[71] | | | + | | | | | | + | | | |
| Johnson (2018)[72] | | | + | | + | | | | + | | | |
| Araùjo et al (2019)[73] | | | + | | | | | | + | | | |
| Araùjo et al (2021)*,[74] | | | + | | | | | = | + | | | |
| Izadi-Najafabadi et al (2021)*,[75] | | | + | | | | | | + | | | |

Note. Abbreviations: "+", improvement; "-", degradation; "±", mixed result; "=", stable result; AMPS, Assessment of Motor and Process Skills; CAPE, Children's Assessment of Participation and Enjoyment; COPM, Canadian Occupational Performance Measure; CSAPPA, Children's Self-Perceptions and Adequacy in Predilection for Physical Activity; ETCH-M, Evaluation Tool for Children's Handwriting; GAS, goal attainment scaling; PEGS, Perceived Efficacy and Goal Setting System; PEM-CY, Participation and Environment Measure for Children and Youth; PQRS, Performance Quality Rating Scale; SSRS, Social Skills Rating Scale; TOGSS, Test Of Grocery Shopping Skills; VABS, Vineland Adaptive Behavior Scales.

* Studies with effect sizes.

**Table 4** Summary of tools for outcomes in domain of contextual factors

| | DIARY/LOGBOOK | EXCHANGES (PARENT) | INTERVIEW | SPPC |
|---|---|---|---|---|
| Miller et al (2001)[29] | | | | = |
| Ward and Rodger (2004)[57] | | + | | |
| Chan et al (2007)[58] | | | | |
| Rodger et al (2007)[59] | + | | | |
| Taylor et al (2007)[60] | | | | |
| Green et al (2008)*,[61] | | | | |
| Rodger et al (2008)[62] | | + | | |
| Rodger and Brandenburg (2009)[63] | | + | | |
| Czmowski et al (2014)[64] | + | | | |
| Gharebaghy et al (2015)*,[65] | | | | |
| Zwicker et al (2015)[66] | | | + | |
| Capistran et al (2016)*,[67] | ± | | | |
| Phelan et al (2009)[68] | | + | | |
| Thornton et al (2016)[69] | | + | | |
| Karunakaran (2017)*,[70] | | | | |
| Anderson et al (2018)[71] | | | + | |
| Johnson (2018)[72] | | | | |
| Araùjo et al (2019)[73] | | | | |
| Araùjo et al (2021)*,[74] | | + | | |
| Izadi-Najafabadi et al (2021)*,[75] | | | | |

Abbreviations: "+", improvement; "-", degradation; "±", mixed result; "=", stable result; SPPC, Self-Perception Profile for Children.
* Studies with effect sizes.

all without a control procedure. Figure 2 illustrates the number of studies with and without a control procedure, by level of evidence and by ICF domain.

Of the 12 studies that considered contextual factors, 1 level III study showed an improvement, as did 4 level IV and 5 level V studies. Only 2 level IV studies showed no improvement. Improvements noted included change in parenting strategies and the improvement in psychosocial factors, such as sense of competence and motor initiative. Parent surveys showed the effect of the CO-OP approach on self-esteem, sense of competence, and autonomy. Parents reported that their children tried new motor activities more readily and were more likely to engage with other children in daily life routines, leisure, or pro-social activities.

## Delivery mode

Group therapy sessions was investigated in 6 studies. One study was a level III and 5 level IV. Only 2 of those had control procedures. Five studies led to an improvement in activities or participation and 1 had mixed results. Only 1 of the 6 studies reported an effect size demonstrating body function improvement.

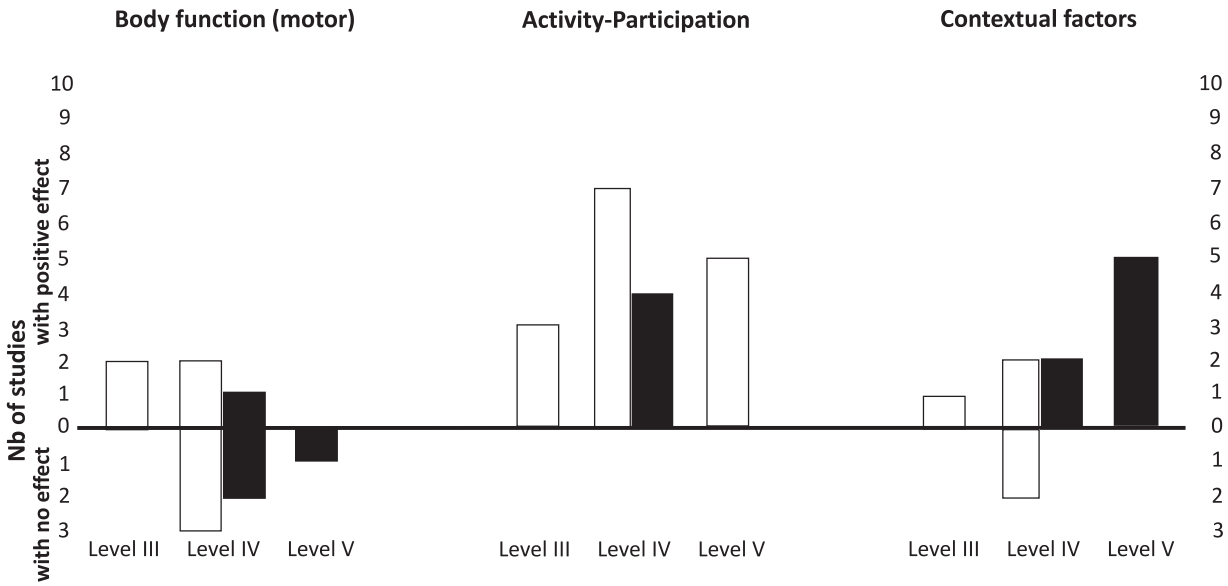


**Fig 2** Note. □= study with control procedure. ■= study without control procedure. As 75% of studies (n=15) measure 2-3 ICF domains, the cumulative number exceeds the number of studies used in this review (N=20).

## Discussion

The objective of this systematic review was to examine the effectiveness of the CO-OP approach in children with NDDs. More specifically, the ICF was used to categorize the effect of the approach on children's functioning. Results suggest that the CO-OP approach has a positive effect on different ICF domains in children with NDDs, particularly on their activities and participation. Indeed, the improvement in activities of daily life, such as riding a bicycle or tying shoelaces, allows children to participate more easily in different situations of social interaction. An effect on body functions was also identified in some studies, seemingly resulting from the interaction of the different ICF domains. The results on contextual factors, particularly environmental factors, also show a positive change in the strategies implemented by parents to help their children after having used the approach. Finally, the analysis highlighted interesting adaptations of the delivery mode, demonstrating the effectiveness of the CO-OP approach when delivered in group therapy sessions. However, this analysis should be nuanced considering the low methodological quality of the studies that were available. In fact, few studies have control procedures that allow for effect sizes to be obtained.

### Effect of the CO-OP approach on ICF components

While all the studies analyzed in this systematic review report that the CO-OP approach has a positive effect on children's activities and participation, the reported effect is mixed in regard to body functions. This outcome is in keeping with the objective of the approach to improve the 3 activities chosen by the child and practiced directly throughout the intervention sessions.[23] It is also in keeping with recent evidence regarding the effectiveness of various approaches in children. For example, in a recent systematic review, Novak and Honan (2019) reported that approaches directly targeting activities of daily life had a positive effect in children with NDDs.[10]

The positive effect of the CO-OP approach on body functions reported in some studies is surprising because the improvement in body functions is not an objective of the approach. In fact, body functions are not directly practiced during the intervention sessions. The systematic nature of the ICF model helps to explain, in part, this outcome. Indeed, according to the dynamic systems theory[37] from which the ICF model is derived, a person's participation results from the interaction of several domains. Other authors writing about the child-environment relation, such as Thelen and Smith (1996), have proposed that participation is also affected by the social dimension.[38] Thus, an improvement in functioning in 1 domain can result in an improvement in 1 or several other domains, particularly in the context of rehabilitation.[39] In fact, a similar outcome was reported by research[40] on the effectiveness of the CO-OP approach in adults that had suffered a stroke at least 1 year earlier. Significant improvements in motor activities that were practiced directly were noted. In addition, a transfer effect was measured on tasks that had not been practiced. Finally, at follow-up 1 month later, people had continued to improve after the end of the intervention.

Recognizing the importance of considering the input from children and families,[41] some of the included studies also examined children's and families' perspectives on the effects of the intervention. Qualitative results of this review provide new insights on the effects of the intervention, particularly those that are related to the environmental factors of the ICF. Results highlight parents' willingness to focus more on opportunities to guide their child through daily challenges instead of compensating their difficulties in terms of function, which is a key focus of the CO-OP approach.[42] Such parents' outcomes demonstrated how the CO-OP approach fosters new opportunities for the generalization and transfer of skills learned outside the therapy setting. A research team[43] in 2021 also reported such results in a recent qualitative study of parents' experiences of the intervention. This systematic review also highlights the effects of interventions that take place in the child's natural environment, such as a child's home, in the community (eg, summer camp) or at school. Interventions taking place in natural settings are favored more and more, as interventions based on activities in an artificial setting do not reflect a truly authentic child-centered approach.[19] It would be interesting to compare the effects of the CO-OP approach on skill generalization and transfer when the interventions take place in different settings. This research avenue is important to support therapists in their advocacy for new service delivery models.

When it comes to examining the effectiveness of CO-OP on contextual factors, interpretation of outcomes must be made with caution because specific quantitative measurements were lacking in the articles selected. Moreover, few studies were carried out with this primary objective, which means that this outcome is difficult to apply to other situations. However, it does provide a good direction for future research.

### Methodological quality of the studies

One of the main limitations of this systematic review is the level of evidence and scientific quality of the studies reviewed. Regardless of the ICF domain measured, the available literature has maintained a low level of scientific quality over time. In fact, only 3 studies included in the systematic review reached level III. The vast majority were level IV or level V. Study designs which provide control procedures are usually those used for RCTs.[44] However, this type of design requires a large number of clients with sufficient homogeneity to allow for group comparisons and calculate effect sizes.[45–47] However, NDDs affect populations that are heterogeneous,[2] which makes such designs difficult. The SCED, which is a lesser-known design, allows for a control procedure with fewer subjects.[30,49] In that design, the client is considered his or her own control. Moreover, the SCED allows for calculation of effect sizes in a typical rehabilitation context,[45] which is not possible with alternative designs, such as the pre-experimental design.[48] Studies on the CO-OP approach for disorders other than NDDs, such as Hyperkinetic Movement Disorder[50,51] or head trauma in adults,[40,52] have benefited from having control procedures and calculation of effect sizes, including the use of the SCED methodology. This analysis shows that only 4 research on the

CO-OP approach in children with NDDs, out of a total of 18 that were available, have effect sizes. Therefore, future studies on the approach in children with NDDs ought to use a design with control procedures and a calculation (or estimate) of effect size in order to improve the evidence supporting the effectiveness of the approach and to help professionals make treatment choices that are optimal. Effect size calculations can help clinicians determine for which NDDs the approach will be the most effective, regardless of the delivery mode (group or individual therapy sessions).

### Delivery mode

About 30% of studies analyzed used the CO-OP approach in group therapy sessions. The approach, like other interventions, can be offered in such a delivery mode. Among other things, the group therapy session reduces health costs,[53,54] because this format shortens wait lists for interventions and promotes access to care for more clients. Therapists provide care to a larger number of clients, for the same amount of time, compared with conventional care provided in an individual format. Another benefit of the group therapy session for treatment is that it promotes learning through social interaction.[55] The group therapy session provides opportunities for reinforcement or rewarding clients with peer feedback, which is often more powerful than reinforcement from adults or therapists. For DCD, current international recommendations call for therapists to use small intervention groups (four to 6 clients), if possible, for maximum benefits.[3] Those recommendations are based on an effect measurement that favors intervention groups rather than individual interventions.[12] For the CO-OP approach in particular, an integrative review of the literature[25] in 2017 highlights the lack of available results for the group therapy sessions to be an evidence-based practice despite a positive trend toward this delivery mode. This lack of evidence is due in part to the small number of articles available, but also to the methodological biases of the studies performed. This systematic review added 5 additional studies to the review published by Anderson et al in 2017.[25] However, designs used in the newer studies do not allow for a verdict on very high level of evidence results.[56] Ultimately, there is a need for more rigorous work where a group intervention mode is offered for the CO-OP approach.

## Study limitations

This review has several limitations, as all research. The review was limited to articles in English and in French, and therefore did not capture literature in other languages. This systematic review shows that the CO-OP approach is an effective intervention for improving activities and participation in children with NDDs in general. Nonetheless, given that very few studies achieved high quality scores, current recommendations must be considered with caution and confirmed by future clinical research. Indeed, few studies used control procedures, which means an increased risk of biases. Although most of the studies establish a clinically significant difference in improving activities and participation, it is recommended that further research be done using control procedures to establish effect size. Such research would improve the quality of the evidence on the effectiveness of the CO-OP approach. The literature could also benefit from qualitative or mixed designs to investigate the effects of primary interest on families and children. For those reasons, results of this systematic review should be interpreted with caution.

## Conclusions

The CO-OP approach is an intervention that it is not intended to provide an improvement in specific body functions, but rather to improve the general functioning in daily life (activities and participation) as well as the child's involvement in his or her activities (personal factors) or the interaction between the child and his or her parents (environmental factors). Studies on the CO-OP approach demonstrate being effective in improving activity performance in children with NDDs, particularly DCD. However, measurement of effect size for children with NDDs in general, including DCD, remains unresolved. There is a critical need for stronger evidence on the effectiveness of CO-OP interventions in children with NDDs, particularly on the delivery mode of the intervention (group vs individual therapy setting) in line with recent research on the topic. More studies that are rigorous are needed to examine the effects of different environments and their specific effect on activity, participation, and body functions.

## Supplier

a. EndNote Clarivate.

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