

Effectiveness of School-Based Occupational Therapy Interventions on School Skills and Abilities Among Children With Attention Deficit Hyperactivity and Autism Spectrum Disorders: Systematic Review

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Abstract

This systematic review aimed to synthesize the best available research evidence regarding the effectiveness of school-based occupational therapy interventions on school skills and abilities among children with ADHD (attention deficit hyperactivity disorder) and ASD (autism spectrum disorder). The review was conducted according to JBI (Joanna Briggs Institute) guidelines (Aromataris & Munn, 2020). A three-step search strategy was conducted from five electronic databases (CINAHL, PubMed, OTDBASE, Google Scholar, and Oula-Finna) in January 2022. This review considered randomized and quasi-randomized studies that evaluated school-based occupational therapy interventions for children on school skills and abilities, specifically outcomes of social interaction and process skills, and cognitive abilities.

Results: This review includes thirteen studies with a total sample size of 375 participants. Results are divided into two categories: school-based occupational interventions for children with ADHD (three studies) and school-based occupational interventions for children with ASD (ten studies). Results from school-based occupational therapy intervention studies for children and adolescents with ADHD indicate that this group of students benefits from manualized interventions that focus on social interaction skills, process skills, and cognitive abilities. Positive responses to these outcomes were found when using interventions concerning mindfulness, weighted vests, and executive function training programs. Results from school-based

occupational therapy intervention studies for children and adolescents with ASD emphasize using interventions that affect social interaction skills.

Introduction

Occupational therapy (OT) combined with education is a necessary and relevant service that continues to evolve in the 21st century. School-based occupational therapy focuses on students' engagement in meaningful, essential occupations that support access, learning, and participation in school. School-based occupational therapy practitioners support students, school staff, and parents at multiple levels: at the system level providing services for school districts; at the group level providing services for the whole classroom or guidance for teachers; and at the individual level working with individual students through multi-tiered systems of support programs (Clark et al., 2019, p. 11). Designing solutions for students' learning challenges in an interprofessional team with teachers, parents, and other educational staff is a core of school-based occupational therapist work (Dunn et al., 2017, p. 240).

Students can face multiple challenges in their school skills and abilities throughout their school years (Clark & Ponsolle-Mays, 2019, p. 12). Skills are learned through behavioral patterns that can be divided into motor, process, and social interaction skills. Abilities refer to the capability to perform the skill and can contain mental, sensory, motor, cognitive, and social functions (AOTA, 2020). Students' challenges in skills and abilities can occur and vary in many areas of occupations (Clark & Ponsolle-Mays, 2019, p. 12). For example, difficulties in process skills (e.g., organizing time and objects, applying knowledge and adapting performance) can affect learning, whereas challenges in social interaction skills (e.g., verbal and nonverbal communication skills and adapting social interaction) can affect friendships with peers (AOTA 2020).

Cognitive abilities are part of physiological function of body system, that refers to the ability of human brain process, store and extract information, including attention and memory (Shi & Qu, 2021). All these factors have important effect to students' academic success. Sensory abilities refer to using senses like hearing and vision. Differences in sensory processing occur at behavioral, perceptual and neural level and can affect students' occupational performance at school in many ways (e.g. over-respond to auditory input in class) (Butera et. al., 2020).

In schools, occupational therapy practitioners focus on enhancing skills and abilities to ensure students' participation in physical, cognitive, psychosocial, and sensory components of occupational performance by using occupation-based interventions (Law & Dunn, 2017, p. 115). Occupational performance can be seen as a dynamic relationship between a person, environment, occupation, and a person's developmental stage, culture, and societal roles. These impact their ability to perform the tasks and activities that are important to them (Law & Dunn, 2017, p. 115). With the unique contribution of school-based occupational therapy, the practitioner creates the opportunity for students to gain the skills, abilities, and confidence to accomplish meaningful activities and, by doing so, increase students' occupational performance (Law & Baum, 2017, p. 4).

Children with ADHD in schools

With a prevalence of over 5%, attention deficit hyperactivity disorder (ADHD) is one of the most frequent disorders in childhood (Drechsler et al., 2020). In the DSM-5, the defining symptoms are divided into inattention symptoms (11 symptoms) and hyperactivity/impulsivity symptoms (9 symptoms). In order to fill the diagnostic

criteria, symptoms must be present in two or more environmental settings before 12 years old for at least six months. They must reduce or impair social, academic, or occupational functioning (American Psychiatric Association, 2013). Children and adolescents with ADHD face significant obstacles when trying to conduct normal school activities, and they may require support to access, participate in, and progress in their educational programs (Clark, 2019). They are expected to sit, often for long periods, although they face problems with high activity levels. Children with ADHD are also expected to maintain attention during lessons, although focusing and maintaining attention is a core problem in ADHD (Reid & Johnson, 2011, p. 66). Social challenges may also cause problems in school, as children with ADHD have difficulties predicting the consequences of their actions and responding appropriately. Children with ADHD often underachieve academically, and most have learning problems. Executive functions, such as working memory, are often poor, which can be seen as having problems in school (e.g., difficulties remembering information or instructions, trouble following the plot when reading a book, forgetting their schoolbooks, etc.). They often face low self-esteem, performance inconsistency, poor motivation, and mental health problems. They can also face problems like clumsiness, inflexibility (fixation on specific rules, difficulties finding compromise), insatiability (not knowing when to stop), and sleeping problems (Selikowitz, 2021, pp. 13–14). ADHD behavioral problems in children are also common and are generally related to hyperactivity (Abrahao & Luciana Carla do Santos, 2021).

School-based occupational therapy practitioners can help students with ADHD with different types of interventions depending on individual goals set for the student. Based on a national survey in Canada (Ianni et al., 2021), school-based occupational therapists

reported intervening most in the areas of fine motor skills, sensory processing abilities, and “school functioning,” which refers to the student’s ability to participate in school-related activities. Proper classroom placement, educational planning, and rehabilitation are essential components of ADHD management (McGough, 2014, p. 52). School-based occupational therapy practitioners can help the student, educational staff, and parents in multiple ways, e.g., by providing rehabilitation at the neurological and behavioral levels, adapting the classroom environment and routine, enhancing task performance, and educating parents and teachers about ADHD (Chu & Reynolds, 2007).

Children with ASD in school

Autism spectrum disorder (ASD) is a term used to describe a set of early-appearing social deficits and repetitive sensory-motor behaviors that can change from mild to severe (Lord et al., 2018). The estimated prevalence of ASD is about one child in 160 children (WHO, 2021), and ASD is four times more common among boys than girls (Maenner et al., 2021). According to DSM-5, persistent, lifelong challenges in social communication can include abnormal social approach, failure of normal back-and-forth conversation, reduced sharing of interests and emotions, deficits in nonverbal communicative behaviors, and deficits in developing, maintaining, and understanding relationships. ASD individuals also have restricted, repetitive behavior patterns, interests, and activities, including problems with sensory input (American Psychiatric Association, 2013). A noisy and chaotic school environment can be hard to handle for children and adolescents with ASD, with the preference for routine and consistency that many individuals with ASD exhibit (Humphrey & Lewis, 2008). Social life at school—

entering a peer group, making friends, and developing friendships—can also be tricky for students with ASD. With all the challenges students with ASD experience, these individuals need consistency in the school environment, support in interpersonal connections, psychoeducation about autism, and an effective support system in school (Hedges et al., 2014). School occupational therapy practitioners can support these individuals by enhancing the skills and abilities needed in autistic students' everyday school life (Grandisson et al., 2020) by promoting their access and participation in all aspects of the classroom and school routines, including academic performance, social interaction, play with peers, and engagement in afterschool activities (Kuhaneck & Watling, 2019).

Current study

Synthesized and evidence-based research is narrow concerning school-based occupational therapy interventions for students with ADHD and ASD. Only one systematic review was found that focuses on play-based interventions for ADHD children in a school context (Cornell, Lin & Anderson, 2019). As such, no comprehensive reviews on the effectiveness of manualized school-based occupational therapy interventions specific to the needs of students with ADHD and ASD children's school skills and abilities may be available in the field of occupational therapy. To capture the findings of this body of literature, we conducted a systematic review guided by the focused research question: "What is the current evidence for the effectiveness of school-based occupational therapy interventions on school skills and abilities for children aged 6–15 with ADHD and ASD?"

Methods

Search strategy

A systematic literature review was conducted to evaluate the effectiveness of school-based occupational therapy interventions for children with ADHD and ASD on school skills and abilities. The research question was determined by using a Population Intervention Comparison Outcome (PICO) framework (Sayers, 2008) (P = ADHD and ASD children aged 6–15, I = school-based occupational therapy interventions, C = compared with children with ADHD and ASD not receiving school-based occupational therapy, and O = school skills and abilities).

First, the first author searched for evidence from research articles published between 2011 and 2021 in English from electronic databases (CINAHL, PubMed, OTDBASE, Google Scholar, and Oula-Finna). No manual search was used. The following key search terms were used in all databases: ADHD, attention deficit hyperactivity disorder, Asperger*, autism*, school-based occupational therapy, and pediatric occupational therapy (See **Table 1**). The search terms were modified and selected with help from an informaticist specialist. The literature search was finished in January 2022. In addition to the database search, the first author hand-searched the reference lists of all included articles to identify additional studies not captured in database searches.

<Insert table 1. here>

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were established before conducting the systematic review to provide the structure for study selection. Inclusion criteria were defined based on the PICO research question as follows: a.) participants were aged 6–15 years old

with diagnosed ADHD or ASD, b.) school-based occupational therapy interventions were targeted to children, c.) study design was a randomized controlled trial (RCT) or quasi-experimental, d.) articles included were peer-reviewed, and e.) articles were published in English, Finnish, or Swedish between and including the years 2011 and 2021. The publication year was limited to ten years as the aim was to find the newest research articles. A set of exclusion criteria were also applied: a.) the research article was not peer-reviewed (example conference proceedings, non-peer reviewed publications, dissertations, theses, and presentations) were excluded., b.) language other than English, Finnish, or Swedish, c.) publication year earlier than the year 2011, d.) the participant's mean age was < 6 or > 15 years, e.) interventions were not targeted to children who were diagnosed with ADHD or ASD, f.) study setting was the home, other institution, or hospital, g.) intervention was not related to occupational therapy and h.) study design other than RCT or quasi-experimental.

Study Selection and Risk of Bias Assessment

Literature search results were collected using Covidence, a cloud-based systematic review software program (Veritas Health Innovation Ltd, 2022). A total of 782 studies were imported for screening, of which 388 duplicates were removed, leaving 394 studies for the title and abstract screening. The title and abstract screening of the search results was conducted by two researchers (A.W. & J. K.), and articles that did not match the inclusion criteria were eliminated (**Appendix 1**). The full-text review was also conducted independently by the first and third authors. In case of conflict, the authors (A.W. & J. K.) discussed the disparity and reached a consensus. A total of 24 studies were assessed for eligibility, and of those, 11 studies were discarded for wrong study design (5), wrong study setting (4), wrong patient population (1), and not being a research article (1). Thirteen (13) studies met the inclusion criteria. They were eligible

to proceed to the risk of bias assessment (**Figure 1**, PRISMA [Moher et al., 2009] diagram for selecting the included studies within a systematic review).

<Insert Figure 1. here>

The researchers assessed the risk of bias using a critical appraisal tool from Joanna Briggs Institute (JBI) for Randomized Controlled Trials (RCT) and Quasi-Experimental Studies. The JBI critical appraisal tool for RCTs consists of 13 questions (Tufanaru et al., 2020) and the JBI critical appraisal checklist for Quasi-Experimental studies consists of nine questions (JBI, 2020). Both tools consist of questions concerning bias related to selection and allocation, administration, measurement of the outcome, participation retention and statistical conclusion validity. Each criterion was rated one point if the answer was “yes” and zero points if the answer to the question was “no.” (Tufanaru et al., 2020; JBI, 2020.) Two independent reviewers conducted the assessment (A. W. & J. K.). After rating each one of the studies independently, the ratings were compared. In case of conflict, we arrived at a consensus score through discussion. We did not exclude studies based on critical appraisal scores as we wanted to fully understand the existing literature on the topic to guide future research efforts.

Data extraction

The data extraction form used in this systematic review was detailed and consisted of the following information from each category: (1) references, (2) population, (3) sample size, (4) intervention, (5) assessment tools, (6) study design, (7) critical appraisal score and (8) results. Given the heterogeneity of outcomes measured, the meta-analysis could not be conducted, and the results are presented as a narrative synthesis.

<Insert table 2. here>

Results

Study characteristics

Thirteen articles met the inclusion criteria: two randomized controlled trials (Janeslätt et al., 2014; Buckle et al., 2011) and eleven quasi-experimental studies (Hample et al., 2020; Cheung et al., 2018; Cheung et al., 2020; Patten Koenig et al., 2021; Chaimaha et al., 2017; Garg et al., 2013; Leinfuss & Karnes 2021; Onwumere et al., 2020; Pierce et al., 2020; Virone 2021; Mills et al., 2021). Five of the quasi-experimental studies were pilot studies. There was variation in the publication countries; seven studies were done in the USA, two in China, and one in each of the following countries: Thailand, Australia, South Africa, and Sweden. All studies were written in English. The intervention studies reported multiple outcomes through a variety of measurement tools. The included studies comprised a total of 375 participants.

Critical appraisal

The methodological quality of the included studies varied in quasi-experimental studies from 5/9 to 9/9 (Md = 7 points) when using the JBI Critical Appraisal Tool for Quasi-Experimental Studies (JBI, 2020). Critical appraisal scores for included randomized controlled trials were 7/13 and 8/13 (Md = 8 points) when using the JBI Critical Appraisal Tool for Randomized Controlled Trials (Barker et al., 2023). See **Table 3** for specific scores assigned to all included studies.

<Insert table 3. here>

For the synthesis, we only chose primary outcomes that were measured with valid and

reliable tools. Results from the articles were organized into two themes: school-based OT interventions targeted to children with ADHD and school-based OT interventions targeted to children with ASD.

School-Based OT Interventions for Children with ADHD

Three of the included studies were primarily targeted to examine the effectiveness of school-based OT interventions for children with ADHD. The results can be categorized by outcomes of cognitive abilities, process skills, and social interaction skills.

In the first quasi-experimental study, Chaimaha et al. (2017) investigated the effectiveness of an executive function training program for students with ADHD and executive function deficits (EFDs). Participants comprised eight upper primary school students with ADHD with EFDs without a control group (one group pretest-posttest design). Students received two intervention programs three times a week over seven weeks. Therapeutic programs comprised executive function training and collaborative programs for parents, teachers, and peers. Working memory, planning, monitoring, and academic performance were measured with three standardized tests: Behavior Rating Inventory of Executive Function assessment (BRIEF) (Gioia et al., 2000), Tower of London assessment (TOLDX) (Culbertson & Zillmer, 2005), and The Wechsler Intelligence Scale for Children-Revised assessment (WISC-R) (Wechsler, 1974). Studies found statistically significant improvements in all outcome measurements on students' cognitive abilities ($p < 0.05$). The authors indicated that the therapeutic programs improved students' executive function, especially working memory, planning, and monitoring (Chaimaha et al., 2017).

Another study investigated the effectiveness of weighted vests in a school environment for children with ADHD on process skills (Buckle et al., 2011). The study was implemented as an RCT and comprised 30 participants aged six to nine years old diagnosed with ADHD. Participants wore weighted vests during school days, 45 minutes each day for 15 consecutive school days. In this study primary outcomes were process skills of in-seat behavior and task completion speed, measured using a stopwatch. Attention to task was measured using Conners' Continuous Performance Test II (CPT II) (Conners, 2000). Buckle et al. (2011) found that weighted vest intervention improved their process skills for in-seat behavior, task completion speed, and attention to task ($p < 0.05$).

The third study in this category studied the effectiveness of mindfulness intervention on emotional regulation and impulse control. Participants were middle school aged adolescents with ADHD (Virone, 2021). Students received six weeks of programmed intervention and twelve sessions at the beginning of the school day, addressing deep breathing, body scans, sensory awareness, creative expression, psychoeducation, and homework. This study was implemented as quasi-experimental and quantitative data was obtained through pre- and posttest using BRIEF-2 (Gioia et al., 2015) assessment. Six out of eight participants had positive outcomes ($p = 0.02$) on social interaction skills concerning emotional regulation and impulse control. Participants demonstrated a decrease in the frequency of external notification of negative symptoms and desired to gain greater control over symptom management (Virone, 2021).

<Insert table 4. here>

School-Based OT interventions for children with ASD

Seven of the included studies were primarily targeted to examine the effectiveness of school-based OT interventions for children with ASD. Additionally, two included studies (Garg et al., 2013; Pierce et al., 2020) had participants diagnosed with ASD, and the rest had other diagnoses (e.g., learning disabilities and cognitive disabilities). One study (Janeslätt et al., 2014) had participants diagnosed with ADHD and ASD. However, as the number of participants in students with ASD was larger, the findings of this study were synthesized in this category.

Intervention effects on social interaction skills and process skills

Koenig et al. (2012) and Garg et al. (2013) investigated the effectiveness of school-based yoga intervention for ASD children's social interaction skills. Both examined the effectiveness of the Get Ready to Learn program with a quasi-experimental study design. Koenig et al. (2012) found a notable change in children's maladaptive behavior in the intervention group compared to the control group ($p = 0.029$). Children in the intervention group were significantly less irritable and hyperactive. There were also positive lethargy and social withdrawal changes in participants' behavior. Garg et al. (2013) suggest that the school-based Get Ready to Learn program improved participants' classroom behavior in their level of independence, attention, transition, and self-regulation ($p \leq 0.05$). These studies (Koenig et al., 2012; Garg et al., 2013) found improvements in the outcomes of participants' process and social interaction skills in school and suggested that children with ASD benefit from daily manualized yoga interventions before class sessions instructed by teachers that were trained by occupational therapists.

Onwumere et al. (2020) used a strength-based Independence Curriculum (IC) intervention targeted to children with ASD to examine its effectiveness on outcomes of social interaction skills (self-determination, self-regulation) and process skills (executive function). Participants were autistic 5th graders who received IC-based occupational therapy once a week for a full academic year in a school setting. In this quasi-experimental study, the authors found that implementing the IC led to significant changes in student self-rating of self-determination, executive function, and community skill development measured by Self-Determination Assessment (AIR-S) (Wolman et al., 1994) ($p = 0.002$) and by Vineland Adaptive Behavioral Scales (VABS-II) (Sparrow et al., 2005) ($p = 0.04$). Authors (Onwumere et al., 2020) claim that IC is beneficial in addressing challenges when working with autistic students and that self-determination, self-regulation, and executive function are vital components when building these adolescents' independence in daily life.

Cheung et al. (2018) investigated the effectiveness of a social cognitive intervention on adolescents with ASD. In this relatively small pilot study, researchers used a quasi-experimental study method to examine whether a social cognitive intervention impacted autistic adolescents' social interaction skills. Outcomes were measured with multiple tests, but statistically, significant increases were achieved in GAS ($p = 0.008$) and Strange Stories Test (ToM) ($p = 0.039$). Authors (Cheung et al., 2018) indicated an improvement in participants' skills to interpret other people's mental states. Cheung et al. (2021) did replicate the study with a larger sample size and with a waitlist control group and found similar results and a significant rise in scores—ToM ($p = 0.001$), GAS ($p = 0.047$), and SSIS-RS-C ($p = 0.005$). Both studies included homework about social skills and the intervention received at school.

Pierce et al. (2020) found in their research that autistic and other disabled adolescents who received transition readiness OT interventions related to self-determination, functional behavior, and independence skills achieved significantly higher scores ($p < .01$) on Scales of Independent Behavior (SIB-R) (Bruininks et al., 1996), which measures independent adaptive functioning. Students received occupational therapy interventions for two full academic years. Interventions were customized to the goals and abilities of individual students and primarily offered in peer groups of two to six students. Personnel used targeted strategies to support students' social interaction skills in self-determination. Results show that adolescents with ASD receiving services developed functional behaviors at a higher rate than might have been expected from maturation. However, the authors found no significant change in students' self-determination in the posttest.

Intervention effects on sensory processing

Two studies were interested in improving sensory processing skills in children with ASD in a school setting. Leinfuss & Karnes (2021) suggested that a new intervention model, the Ready to Learn and Play framework, may positively impact occupational performance in school for children and adolescents with ASD. The Ready to Learn and Play framework empowers individuals with ASD to recognize and regulate their sensory needs to facilitate occupational performance. The study was implemented with a control group, and students' occupational performance was measured with a Short Child Occupational Profile (SCOPE) (Bowyer et al., 2008). Both groups received OT, but the intervention group also received the Ready to Learn and Play intervention in addition to their OT program. Authors (Leinfuss & Karnes, 2021) found that the

intervention group had a greater positive change in SCOPE score ($p < 0.001$). Hample et al. (2020) searched for evidence by conducting a study with interoception-based intervention for children with ASD in a school setting. Eight autism classroom students engaged in an eight-week intervention once a week. Intervention sessions focused on noticing interoceptive sensations within one or two body parts. The purpose of the intervention was that children with ASD learn to notice changes in their body signals when they are angry, hungry, etc. Results indicated a positive change in participants' ability in sensory awareness measured with an Interoception Awareness Interview (IAI) (Mahler, 2016) ($p < 0.0001$) within a short period of intervention, and students learned to take in new information from their body signals.

Intervention effects on cognitive abilities

Mills et al. (2021) studied the effectiveness of a sensory activity intervention on the outcome of cognitive abilities of children with ASD in a school setting. The intervention group received Sensory Activity Schedule tasks every school day before the class session for ten weeks. Tasks included different sensory activities, e.g., bouncing on a therapy ball, lying flat on a scooter board, or tactile fidgets. Sensory Activity Schedule intervention positively influenced the general ability to use overall cognitive strategies during student with ASD performance of classroom tasks. The authors used PRPP Stage Two Cognitive Task Analysis (Chapparo & Ranka, 2011) to measure the outcome and found a positive statistical difference between the control and intervention groups ($p = 0.02$).

Janeslätt et al. (2014) studied effectiveness of time aid intervention for children with ASD and ADHD in a school context. In this randomized controlled trial, the authors

aimed to evaluate the effectiveness of time aids on the outcome of cognitive abilities, like time processing ability and time management. Participants received individually designed occupational therapy interventions that were aimed to offer the use of time aids (e.g., time rules, adapted calendars, visual aids to promote orientation to the time, etc.). Interventions also contained education to the student's environmental context. Results of this study show that children in the intervention group increased significantly more than the control group in time-processing ability ($p < 0.05$), but in the second outcome (managing one's time), the difference between groups was not significant.

<Insert table 5. here>

Discussion

This systematic review presents the best available evidence for the effectiveness of school-based occupational therapy interventions for children with ADHD and ASD aged 6–15. The recency and the number of studies included in this review indicate that this body of literature is still developing from small pilot studies to more robust study methods. Based on methodological and other inclusion criteria set for this review, findings indicate that only a few studies evaluate the effectiveness of school-based occupational therapy interventions on school skills and abilities for children and adolescents with ADHD (three of the studies included). School-based occupational therapy interventions for children and adolescents with ASD were more broadly represented in this review (ten of the included studies). Interventions, measurement tools, and outcomes varied in both diagnostic groups. Only a few studies (Virone et. al, 2021; Leinfuss & Karnes, 2021; Cheung et. al, 2018, 2021) had a transparent theoretical background derived from occupational therapy or other therapeutic literature. The rest of the studies had interdisciplinary theoretical backgrounds.

Included studies concerning school-based occupational therapy interventions for children with ADHD had a variety of outcomes in process skills, cognitive abilities, and social interaction skills in the school environment. Buckle et al. (2011) suggested that weighted vests were seen as a convenient tool in the classroom with ADHD children but also pointed out that occupational therapy practitioners and teachers should notice that weighted vests do not have a lasting effect. Therefore, vests should be considered a tool for improving attention to task and in-seat behavior for brief moments. In addition, there is a lack of standardized protocols for using weighted vests. Only one study in this category (Chaimaha et al., 2017) included a collaborative program for parents, teachers, and peers when training executive skills on students with ADHD. This essential environmental component was missing in the other two studies (Virone, 2021; Buckle et al., 2011). The Chaimaha and colleagues (2017) study had a robust study design (risk of bias assessment 9/9), where support from school and home was considered. This aligns with recent OT guidelines for children and youth, where ongoing coaching and feedback with parents and teachers is emphasized (Cahill & Beisbier, 2020; Grandisson et al., 2020).

Surprisingly, only one of the included studies focused on social interaction skills on children with ADHD (Virone, 2021). This study highlighted that teaching students the strategies to manage emotions and impulses can improve responses during stressful situations, which may be derived from interactions with peers or teachers. Despite only this study in this category was included in this systematic review, many of the excluded studies in the study selection phase had important study questions concerning social interaction skills. Social interaction skills are one of the areas where children with

ADHD usually underachieve (Selikowitz, 2021). These studies were excluded based on the study methodology or study setting not being a school. As so, we understand that there are promising results in the field of this literature, but there is a lack of evidence of school-based interventions improving social interaction skills. It was also notable that robust studies about play-based occupational therapy interventions for children with ADHD in school settings were also found to be understudied elsewhere (Cornell et al., 2018).

Included studies in school-based occupational interventions on students with ASD focused on social interaction skills, process skills, cognitive abilities, and sensory processing. Social interaction skills were the most broadly represented in this category, a natural finding as children and adolescents with ASD tend to have the most difficulties in occupational performance. Therefore, results from this review encourage school-based occupational therapists to use a variety of manualized intervention programs (e.g., social-cognitive programs (Cheung et al., 2021), Independent Curriculum (Onwumere et al., 2021), Get Ready to Learn (Koenig et al., 2012; Garg et al., 2013) to help these children develop their skills and abilities and participate in their social environment. Based on the results of this review, school-based occupational therapists can also effectively help children and adolescents with ASD in gaining sensory regulation strategies (Leinfuss et al., 2021), interoception awareness (Hample et al., 2020), and cognitive abilities (Janeslätt et al., 2014).

None of the included intervention studies used technology coupled with skills training, although the timeline for included studies was ten years. This finding is inconsistent with the recent guidelines (Cahill & Beisbier, 2020), where the use of technology,

especially with clients with ASD and ADHD, has been highlighted. One study was found concerning multimedia writing support programs for written productivity (Racicot, 2016), but it was discarded in the full-text review phase as the patient population was wrong. Participants did include children with ASD and ADHD, but results concerning these children remained unclear. This body of literature should be considered for study with more targeted participant criteria and strong study methods in future research.

Although this systematic review had outcomes on skills and abilities, school-based occupational therapy practitioners should remember to focus on students' engagement in daily occupations in the school context. That is, using manualized programs with clear activity- and occupation-based strategies (Cahill & Beisbier, 2020). Activity-based, top-down occupational therapy interventions for children have been found to have more considerable clinical gains in a previous large systematic review (Novak & Honan, 2019). This approach was also mentioned in one of the included studies (Onwumere et al., 2020). The authors noted that the Independence Curriculum intervention focused on academic skills and combined functional components that are vital when working with autistic children. Though, recognizing the areas of effective interventions for this population's skills and abilities that lie underneath occupational performance is one way of categorizing findings from this body of literature.

Limitations and strengths

First, there were a small number of included studies, the sample sizes were relatively small, and some were pilot studies. Therefore, generalizability to students with ADHD or ASD is limited. This finding highlights the need for more robust evidence with randomized controlled trial settings. Second, only five out of thirteen included studies

had a control group. We acknowledge that there may be ethical barriers in conducting research with a control group in this population of children with ADHD and ASD in school settings. Due the nature of school-based OT interventions, it would be more relevant to use pragmatic trials with greater number of participants to evaluate the effectiveness of these interventions. Third, the outcomes of the included studies were diverse, so meta-analysis could not be conducted. Also, the interventions used were heterogenic, further limiting the possibility of conducting a meta-analysis. This leads to the conclusion that although we attempted to collect the best available research in this body of literature, the results should be considered carefully. Additionally, we decided to limit the age from 6 to 15 years old based on Finnish primary school context. We recognize that OT in schools have a role beyond that age limit. Last, we acknowledge that it may have been possible for some relevant studies not to be identified in the search, though the literature search was made as comprehensive as possible.

This systematic review was conducted using the JBI guidelines with sensitivity, and it is transparent and repeatable. Study selection and critical appraisal were made with two reviewers, and inclusion criteria were found appropriate. As data extraction is a crucial step in conducting systematic reviews and the most critical task for the validity of the results of a systematic review (Mathes et al., 2017), this phase was done with care. Also, using appropriate and specific software for systematic reviews (Covidence®) may have improved the inner quality of this review.

Implications for practice

As a result of this review, school-based occupational therapists should:

- Consider using weighted vests for brief moments to help children with ADHD to enhance attention and in-seat behavior in class.

- Consider using manualized yoga and mindfulness OT programs for children with ADHD and ASD to enhance these students' social interaction skills in emotional and impulse control.
- Notice that children with ASD social interactional skills could be rehabilitated through OT interventions in school.
- Remember to collaborate with teachers, peers, and parents to maximize the progress in ADHD and ASD children's occupational performance and rehabilitation.

Implications for further research

There is a need for higher methodological quality and robust school-based occupational therapy effectiveness research, especially with ADHD children. Randomized controlled designs and larger sample sizes should be used to get more substantial evidence of effectiveness. There is also a need for play-based occupational therapy intervention studies for younger students in school settings. Future research should also include more studies about technology coupled with skills training with ADHD and ASD children in a school context.

Conclusion

The results explicate well how broad the capability and expertise of school-based occupational therapists must be when working with these children and adolescents. The included studies' interventions, measurements, outcomes, and theoretical backgrounds were diverse. As a result of this systematic review, we must conclude that currently, there is not enough robust evidence in the field of occupational therapy concerning school-based interventions for students with ADHD. In contrast, school-based

occupational interventions for students with ASD were more broadly examined. Most of the included studies used a quasi-experimental study method, and only two were RCTs. By narrowing the inclusion criteria to these study methods, we managed to collect the best available evidence-based body of literature on school-based occupational therapy interventions for children with ADHD and ASD. The findings of this review can be utilized and implicated by school-based occupational therapists, teachers, and researchers.

Declaration of interests

Jonna Tolonen has been a minority owner and a Peili Vision Ltd. board member since 2020. The authors report that there are no competing interests to declare.

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Appendix 1. *List of the excluded studies in the full-text review phase*

1. Barnes, G., Wilkes-Gillan, S., Bundy, A., & Cordier, R. (2017). The social play, social skills and parent–child relationships of children with ADHD 12 months following a RCT of a play-based intervention. *Australian Occupational Therapy Journal*, 64(6), 457–465. <https://doi.org/10.1111/1440-1630.12417> (WRONG SETTING)
2. Chatthong, W., Khemthong, S., & Wongsawat, Y. (2020). Brain mapping performance as an occupational therapy assessment aid in attention deficit hyperactivity disorder. *The American Journal of Occupational Therapy*, 74(2), 7402205070p1-7402205070p7. <https://doi.org/10.5014/ajot.2020.035477> (WRONG STUDY DESIGN)
3. Gutman, S. A., Raphael-Greenfield, E. I., & Salvant, S. (2012). The effect of an occupational therapy role-playing intervention on the social skills of adolescents with Asperger’s Syndrome: A pilot study. *Occupational Therapy in Mental Health*, 28(1), 20–35. <https://doi.org/10.1080/0164212X.2012.650953> (WRONG STUDY DESIGN)
4. Hahn-Markowitz, J., Berger, I., Manor, I., & Maeir, A. (2017). Impact of the Cognitive–Functional (Cog–Fun) intervention on executive functions and participation among children with attention deficit hyperactivity disorder: A randomized controlled trial. *The American Journal of Occupational Therapy*, 71(5), 7105220010p1-7105220010p9. <https://doi.org/10.5014/ajot.2017.022053> (WRONG SETTING)
5. Mills, C., Chapparo, C., & Hinit, J. (2016). The impact of an in-class sensory activity schedule on task performance of children with autism and intellectual

- disability: A pilot study. *British Journal of Occupational Therapy*, 79(9), 530–539. <https://doi.org/10.1177/0308022616639989> (WRONG STUDY DESIGN)
6. Sadr, N. M., Haghgoo, H. A., Samadi, S. A., Rassafiani, M., Bakhshi, E., & Hassanabadi, H. (2017). The impact of dynamic seating on classroom behavior of students with autism spectrum disorder. *Iranian journal of child neurology*, 11(1), 29. [The Impact of Dynamic Seating on Classroom Behavior of Students with Autism Spectrum Disorder - PMC \(nih.gov\)](https://doi.org/10.1177/0308022616639989) (WRONG STUDY DESIGN)
 7. Palsbo, S., Hood-Szivek, P. (2012). Effect of robotic-assisted three-dimensional repetitive motion to improve hand motor function and control in children with handwriting deficits: A nonrandomized phase 2 trial. *American Journal of Occupational Therapy*, 66, 682–690. <https://doi.org/10.5014/ajot.2012.004556> (WRONG SETTING)
 8. Racicot, R. (2016). The effect of multimedia writing support software on written productivity. *Journal of Occupational Therapy, Schools, & Early Intervention*, 9(1), 99–123. <https://doi.org/10.1080/19411243.2016.1162000> (WRONG PATIENT POPULATION)
 9. Taipalus, A. C., Hixson, M. D., Kanouse, S. K., Wyse, R. D., & Fursa, S. (2017). Effects of therapy balls on children diagnosed with attention deficit hyperactivity disorder. *Behavioral Interventions*, 32(4), 418–426. <https://doi.org/10.1002/bin.1488> (WRONG STUDY DESIGN)
 10. Wilkes-Gillan, S. (2014). A peer-mediated school intervention significantly improved the social skills and playground interactions of children with autism spectrum disorder. *Australian Occupational Therapy Journal*, 371–372. <https://doi.org/10.1111/1440-1630.12159> (NOT A RESEARCH ARTICLE)

11. Wilkes, S., Cordier, R., Bundy, A., Docking, K. & Munro, N. (2011). A play-based intervention for children with ADHD: A pilot study. *Australian Occupational Therapy Journal*, 58, 231–240. <https://doi.org/10.1111/j.1440-1630.2011.00928.x> (WRONG SETTING)

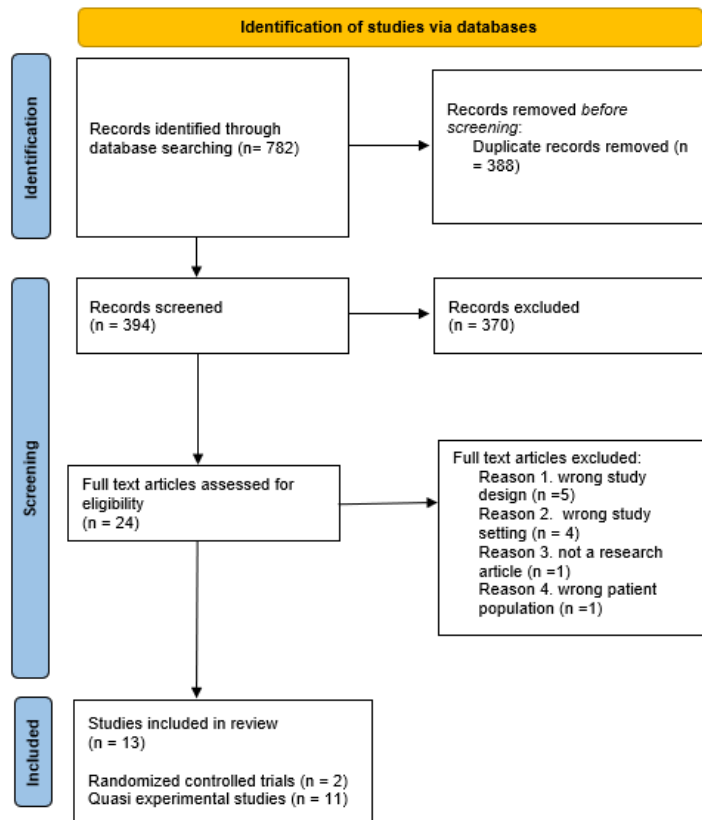


Figure 1. PRISMA Flow Diagram for Selection of the Included Studies Within the Systematic Review

Table 1. *Key Search Terms for the Systematic Review of School-Based Occupational Therapy Interventions Effectiveness on School Skills and Abilities of Children With Attention Deficit Hyperactivity Disorder and Autism Spectrum Disorder*

Category	Key search terms
Population	ADHD OR attention deficit hyperactivity disorder OR attention deficit disorder with hyperactivity OR asperger* OR autism* OR Autistic Disorder
Interventions	school-based occupational therapy OR Pediatric Occupational Therapy
Outcomes	skill* OR ability* OR perform* OR stud* OR Social Skills OR Social Behavior OR Social Skills Training OR Interpersonal Relations OR Motor Skills

Table 2. Data extraction of the included studies

References	Population	Sample size	Intervention	Theoretical background	Measurement tools	Study design	Critical appraisal score (JBI)	Results
Hample et. al 2020	<p>Age range: 7-14</p> <p>Mean age: unclear</p> <p>Gender: 5 male, 3 female</p> <p>Inclusion criteria:</p> <ol style="list-style-type: none"> 1. the children had expressive verbal communications 2. the children received occupational therapy in school 3. the children had a diagnosis of ASD 	n= 8	<p>Name of the intervention: The Interoception Curriculum: A Guide to Developing Mindful Self-Regulation</p> <p>Description: The interoception awarness helps children and adults develop selfregulatory skills by sequentially targeting the ability to notice body signals, connect the body signals to the emotion, and then use a feel-good action to regulate the body-emotion connection.</p> <p>Comparison: -</p>	Unclear	<ol style="list-style-type: none"> 1. The Comprehensive Assessment of Interoceptive Awareness (Mahler, 2016): The Interoceptive Awareness Interview (IAI). 	Quasi-Experimental	7/9	Results indicate positive change and statistically significant postintervention increases in scores on the IAI ($p < .0001$), with preintervention mean scores of 1 (range 0–2), and postintervention mean scores of 7.62 (range 6–11).

	<p>4. the children were between the ages of 6 and 13 years old</p> <p>Clinical characteristics: autism</p> <p>Country: USA</p>		<p>Setting: Classroom</p> <p>Length of session: 30 min.</p> <p>Number of sessions: once a week for eight weeks</p> <p>Group size: 8</p> <p>Intervention deliverers: Occupational therapists</p>					
Cheung et al. 2018	<p>Age range: 12-14</p> <p>Mean age: 12.57</p> <p>Gender: all male</p> <p>Inclusion criteria: autism features (poor social skills,</p>	n=7	<p>Name of the intervention: Social cognitive intervention (The Friendship Lab)</p> <p>Description: The program is designed to teach children with high-functioning ASD how to think and infer regarding other people.</p>	Theory of Mind (ToM)	1. The Chinese version Social Skills Improvement System Rating Scales (SSIS-RS-C) (Gresham & Elliot)	Quasi-Experimental	6/9	The results showed that there was significant increase in goal attainment (GAS) (p = 0.008) and ToM (Strange Stories Test) (p = 0.039). There were increase in the FQS, SSISRS-C, and ToMI scales at post-test, but the gains were not maintained at follow-up.

	<p>limited interaction with peers, lack of friends)</p> <p>Clinical characteristics: Autism spectrum disorder, autism features</p> <p>Country: China</p>		<p>Comparison: -</p> <p>Setting: school</p> <p>Length of session: unclear</p> <p>Number of sessions: 10</p> <p>Total session hours: unclear</p> <p>Group size: 7</p> <p>Intervention deliverers: Occupational therapists</p>		<ol style="list-style-type: none"> 2. Goal Attainment Scaling (GAS) (Ruble et al.) 3. The Friendship Qualities Scale (FQS) (Bukowski et. al) 4. The Strange Stories Test (Kaland et. al) 5. The Theory of Mind Inventory (ToMI-2) (Hutchins et al. 2016) 			
Cheung et. al 2021	<p>Age range: 6-14</p> <p>Mean age: 9.91 years</p> <p>Gender: 91% male in the</p>	n= 74	<p>Name of the intervention: Social cognitive intervention program</p> <p>Description: Intervention program is designed to teach</p>	Theory of Mind (ToM)	<ol style="list-style-type: none"> 1. The Chinese version of the Social Skills Improvement System Rating 	Quasi-Experimental	8/9	There were significant differences between groups in favor of intervention group on three outcome measures, including the GAS scores (p=0.047), the SSIS-RS-C-total scores (p=0.005) and the SSIS-RS-

<p>intervention group and 87% male in the control group</p> <p>Inclusion criteria:</p> <ol style="list-style-type: none"> 1. Diagnoses of ASD 2. An interest in playing with peers of similar ages 3. Children could read, understand, and complete the questionnaires 4. The children had a 			<p>children with ASD how to think and infer regarding other people.</p> <p>Comparison: waitlist group</p> <p>Setting: school</p> <p>Length of session: one hour</p> <p>Number of sessions: once a week for 10 sessions</p> <p>Total session hours: 10</p> <p>Group size: 45 (intervention group), 29 (control group)</p> <p>Intervention deliverers: occupational therapists</p>		<p>Scales (SSIS-RS-C) (Cheung et al. 2017)</p> <ol style="list-style-type: none"> 2. Goal Attainment Scaling (GAS) (Hilton 2012) 3. Strange Stories Test (O'Hare et al. 2009) 4. Theory of Mind Inventory-Second edition (TOMI-2) (Hutchins et al. 2016) 			<p>C-Engagement scale (p=0.046)</p>
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	Country: China							
Koenig et. al 2021	<p>Age range: 5-12</p> <p>Mean age: 9 yr 7 mo (intervention group, 8 yr 7 mo (control group))</p> <p>Gender: 37 male, 9 female</p> <p>Inclusion criteria:</p> <ol style="list-style-type: none"> 1. Diagnosis of an ASD 2. Elementary school age (5-12) 3. no known medical condition that would prevent participatio 	n= 48	<p>Name of the intervention: Get Ready to Learn-program</p> <p>Description: The GRTL program is a daily classroom-based preparatory yoga curriculum developed by Anne Buckley Reen that uses specific developmentally targeted breathing exercises, yoga postures, chanting, and relaxation techniques to enhance the functional and academic performance of students with a variety of disabilities.</p> <p>Comparison: control group, which participated in the</p>	unclear	<ol style="list-style-type: none"> 1. Aberrant Behavior Checklist (ABC)–Community (Aman & Singh) 2. VABS–II (Sparrow et. al) 	Quasi-Experimental	7/9	Students who participated in the GRTL program showed significant differences (p=.029) in total ABC–Community score compared with students in the control condition.

	<p>n on GRTL program</p> <p>Clinical characteristics: Autism spectrum disorder</p> <p>Country: USA</p>		<p>standard morning activity</p> <p>Setting: school</p> <p>Length of session: every school day for 16 weeks for approximately 15-20 minutes/session</p> <p>Number of sessions: unclear</p> <p>Total session hours: unclear</p> <p>Group size: intervention group n = 25, control group n= 24</p> <p>Intervention deliverers: teachers (trained by occupational therapist)</p>					
Chaimaha et.al 2017	Age range: 10-12	n= 8	Name of the intervention: the EF training program	unclear	1. The BRIEF assessment	Quasi-Experimental	9/9	Statistically significant improvements with large effects sizes were found on

	<p>Mean age: unclear</p> <p>Gender: unclear</p> <p>Inclusion criteria: First group: 1. studying in upper primary school grade 4–6 2. diagnosed with ADHD by a psychiatrist 3. having T-scores of 65 or over for working memory, planning, and self-monitoring on the Behavior Rating Inventory of Executive Function or BRIEF</p>		<p>Description: The EF training program was intended to facilitate EFs, specifically in working memory, planning, and monitoring skills, of the students with ADHD with EFDs through a computer-administered format and a paper-and-pencil format.</p> <p>Comparison: -</p> <p>Setting: school</p> <p>Length of session: 60-minute sessions completed 3 times a week over a 7 weeks period</p> <p>Number of sessions: 21</p>		<p>(Gioia et al., 2000)</p> <ol style="list-style-type: none"> 2. The Tower of London-Drexel University, 2nd edition (TOLDX) (Culbertson & Zillmer, 2005) 3. The Revised Wechsler Intelligence Scale for Children (WISC-R) digit span subtest (Wechsler, 1974) 		<p>the BRIEF Teacher Form in the composite index and domain scores ($p < .05$). The Parent BRIEF, and Parent GEC scores showed statistically significant improvements after intervention ($p < .05$). However, statistically significant improvements were not found on the BRIEF Parent Form in working memory, planning, and monitoring.</p> <p>On the TOLDX, the study found statistically significant improvements with large effects sizes in Total Initial Time, Total Execution Time, and Total Time after intervention ($p < .05$). Students initiated the assessment tasks with thoughtful preparation and planning within a timely manner. In fact, the results indicated that the students completed the tasks in less time, which was consistent</p>
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	<p>4. not receiving occupational therapy treatment or special education during the study period</p> <p>5. willingness to participate in the study with signed a letter of the child's assent and their parents' consent.</p> <p>Clinical characteristics: ADHD</p> <p>Country: Thailand</p>		<p>Total session hours: 21</p> <p>Group size: 8</p> <p>Intervention deliverers: occupational therapist</p>					<p>with the teachers' report on the BRIEF Teacher Form.</p> <p>On the WISC-R (digit span subtest), results in the working memory component reported significant improvements with large effects sizes ($p < .05$).</p>
Garg et. al 2013	<p>Age range: 5-9</p> <p>Mean age: unclear</p> <p>Gender: unclear</p>	n= 51	<p>Name of the intervention: Get Ready to Learn (GRTL) program</p> <p>Description: The Get Ready to Learn</p>	unclear	1. Get Ready to Learn Supplemental Data Sheet (Buckley-Reen 2009)	Quasi-Experimental	5/9	Results of the paired t-test showed statistically significant improvements on all four dependent variables before and after implementation of the GRTL program.

	<p>Inclusion criteria: 1. elementary students 5 to 9 years old, receiving special education services in self-contained classrooms in District 75, a special education district in New York City 2. classified with a diagnosis of multiple handicapping conditions, developmental disabilities, or ASD.</p> <p>Clinical characteristics: 43% multiply handicapped,</p>		<p>(GRTL) program created by Anne Buckley-Reen, OTR, is a manualized classroom-based preparatory curriculum that was developed to enhance the functional and academic performances of students with disabilities using yoga postures, relaxation, chanting, and breathing exercises.</p> <p>Comparison: -</p> <p>Setting: school</p> <p>Length of session: 20 minutes</p> <p>Number of sessions: The GRTL program was administered between 12 to 26 weeks. For purpose of analysis, the</p>				<p>Students demonstrated a statistically significant improvement on all four classroom behaviours regardless of the length of the implementation period.</p>
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	<p>22% developmentally delayed, and 35% of the students with a diagnosis of ASD.</p> <p>Country: USA</p>		<p>intervention period was divided into three types of duration periods: low duration of 12 to 15 weeks; medium duration of 16 to 19 weeks; and high duration of 20 to 26 weeks.</p> <p>Total session hours: unclear</p> <p>Group size: five classrooms, specific group size unclear</p> <p>Intervention deliverers: teachers (trained by occupational therapists)</p>					
Janeslätt et al 2014	<p>Age range: 6-11</p> <p>Mean age: 8.57</p> <p>Gender: female 32%, male 68%</p>	n= 47	<p>Name of the intervention: Intervention using time aids</p> <p>Description: Prescribing and</p>	unclear	1. KaTid-Child (Kit for assessing Time-processing ability in	Randomized Controlled Trial; Randomized Block Design	7/13	The results showed that children in both groups gained significantly in time-processing ability between the first and second data collection, and children in the intervention group

	<p>Inclusion criteria: children with developmental and intellectual disabilities aged 6-11</p> <p>Clinical characteristics: ADHD (n = 5), ASD (n = 7), ID (n = 16), physical disability including CP and spina bifida (n = 17), and double diagnosis (n = 2)</p> <p>Country: Sweden</p>		<p>supporting the use of assistive devices is an intervention frequently used by occupational therapists (OT) to increase participation in children with disabilities.</p> <p>Comparison: wait-list group</p> <p>Setting: school and participants' home</p> <p>Length of session: 1 1/2–2h</p> <p>Number of sessions: 3–11 (mean 5.6) meetings as well as 3–5 occasions for assessment</p> <p>Total session hours: unclear</p>		<p>children) (Janeslätt et. al 2008)</p> <p>2. Time-Parent scale (Janeslätt et. al 2008)</p>			<p>increased significantly more during intervention than children in the control group during the waiting-list time.</p>
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			<p>Group size: intervention group n=17, control group n=18</p> <p>Intervention deliverers: occupational therapists and one special education teacher</p>					
Buckle et. al 2011	<p>Age range: 6-9</p> <p>Mean age: unclear</p> <p>Gender: 70% male, 30% female</p> <p>Inclusion criteria: having definite difference scores in School Factors one and two on the Sensory Profile</p>	n= 30	<p>Name of the intervention: weighted vests in classroom with learners diagnosed with ADHD</p> <p>Description: Weighted vests can be used as part of a balanced sensory diet which includes a personalized activity plan that provides sensory input that a person needs to stay</p>	unclear	<ol style="list-style-type: none"> 1. In-seat behavior (the length of time learners were able to stay seated, measured in minutes by stopwatch) 2. Task completion speed (time measured in minutes by stopwatch) 3. Conners' Continuous 	Randomized Controlled Trial	9/13	The results showed significant improvement of in-seat behaviour (Group B), task completion speed (Group A) and attention to task (Group A and B) was observed while participants wore weighted vests.

	<p>while on medication.</p> <p>Clinical characteristics: ADHD</p> <p>Country: South Africa</p>	<p>focused and organized throughout the day.</p> <p>Comparison: control group</p> <p>Setting: school</p> <p>Length of session: 20 minutes</p> <p>Number of sessions: Six phases containing ten times observation in in-seat behavior, ten times observation in task completion and three times assessment in CPT-II (for groups A and B)</p> <p>Total session hours: 60x 20min. observations</p> <p>Group size: 15</p> <p>Intervention deliverers:</p>		<p>Performance Test II (CPT II) (Conners 2000)</p>			
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			occupational therapists, teachers and school counsellors					
Leinfuss & Karnes 2021	<p>Age range: 5.3 – 16.4 (intervention group), 8.1 – 18.10 (control group)</p> <p>Mean age: unclear</p> <p>Gender: all male</p> <p>Inclusion criteria:</p> <ol style="list-style-type: none"> 1. full-time enrollment at the school for at least seven of the nine months of data collection 2. received occupational therapy services mandated by the student's home 	n= 9	<p>Name of the intervention: Ready to Learn and Play</p> <p>Description: Ready to Learn and Play provides a framework for occupational therapists to use with clients with ASD and their caregivers. Individuals with ASD as well as their caregivers benefit from being taught how to recognize sensory seeking, avoiding, self-stimulatory and repetitive behaviors as clues to a sensory processing need.</p> <p>Comparison: control group receiving OT</p>	Behavioral psychology and education & OT theory	1. Short Child Occupational Profile (SCOPE) (Bowyer et al. 2008)	Quasi-Experimental	6/9	Results show that all children who received OT demonstrated growth in occupational performance, which worked toward the goals of the students' IEPs. However, when comparing SCOPE scores between the two groups, a statistically significant change in occupational performance was seen in the intervention group who also received the RtLP intervention in addition to their OT program. All of the children in the RtLP intervention group experienced improvements with an increase of at least 18 points, (range of 18–33-points) on the SCOPE. This is noted to be significantly different than the control group which also showed

	<p>district 3. documented diagnosis of ASD</p> <p>Clinical characteristics: Autism Spectrum Disorder (ASD)</p> <p>Country: USA</p>		<p>(not Ready to Learn and Play framework)</p> <p>Setting: school</p> <p>Length of session: unclear</p> <p>Number of sessions: unclear</p> <p>Total session hours: data was collected nine months (a full school year). Total session hours unclear.</p> <p>Group size: 5 (intervention) and 4 (control)</p> <p>Intervention deliverers: Occupational therapists</p>					improvement but of 1–6 points.
Onwumere et. al 2020	Age range: fifth graders, age 10-13	n= 13	Name of the intervention: Independence Curriculum	unclear	1. Goal Attainment Scaling (GAS)	Quasi-Experimental	8/9	The results of this study suggest that implementing the IC led to significant changes in student self-

	<p>Mean age: unclear</p> <p>Gender: unclear</p> <p>Inclusion criteria: Students must perform on or above grade level and have an educational classification of ASD on their IEP, as confirmed by the Autism Diagnostic Observation Schedule (ADOS)</p> <p>Clinical characteristics: Autism Spectrum Disorder</p> <p>Country: USA</p>		<p>Description: Independence Curriculum (IC) provides instruction and support to enhance an individual's DLS, self-determination, executive function, and self-regulation skills. The IC consists of (a) the Middle School Checklist (student, parent, and teacher/service provider versions), (b) five units (e.g., student roles, DLS, self-advocacy, social participation and interests, community integration), and (c) lists of suggested activities</p> <p>Comparison: -</p> <p>Setting: school</p>		<p>(Ruble et. al 2012)</p> <ol style="list-style-type: none"> 2. Vineland Adaptive Behavior Scales, 2nd Edition (VABS-II) (Sparrow et. al 2005) 3. The AIR Self-Determination Scale (Wolman et. al 1994) 4. Middle School Checklist: The Middle School Checklist (Onwumere et. al 2016) 			<p>rating of self-determination, goal attainment in self-regulation, executive function, and community skill development of autistic students as measured by the AIR-S, GAS, and VABS-II respectively.</p>
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			<p>Length of session: 40-45 min.</p> <p>Number of sessions: once a week for a full academic school year</p> <p>Total session hours: unclear</p> <p>Group size: 5 students, 10 groups (not all students participated the study)</p> <p>Intervention deliverers: occupational therapists</p>					
Pierce et. al 2020	<p>Age range: 14-16</p> <p>Mean age: unclear</p> <p>Gender: unclear</p>	n= 42	<p>Name of the intervention: Transition Readiness Intervention</p> <p>Description: transition services improve the academic and functional</p>	unclear	1. The SIB-R (Bruininks et. al 1996)	Quasi-Experimental	7/9	PCI scores for all SIB-R scales demonstrated that students receiving services developed functional behaviors at a higher rate than what might have been expected from maturation.

	<p>Inclusion criteria:</p> <ol style="list-style-type: none"> 1. age 14 at start of intervention 2. disability 3. inclusion in regular education 4. English-speaking 5. minimum IQ of 60 <p>Clinical characteristics: 20 learning disabilities, four multiple disabilities, four cognitive disabilities, six autism, one Asperger's, and seven other health impairments</p> <p>Country: USA</p>		<p>achievement of the child with a disability to facilitate the child's movement from school to post-school activities, including postsecondary education, vocational education, integrated employment (including supported employment); continuing and adult education, adult services, independent living, or community participation.</p> <p>Comparison: -</p> <p>Setting: school</p> <p>Length of session: one hour</p> <p>Number of sessions: one session per week for two full academic years</p>				
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			<p>Total session hours: unclear</p> <p>Group size: two to six students, also occasional one-to-one sessions were provided</p> <p>Intervention deliverers: occupational therapists</p>					
Mills et. al 2021	<p>Age range: 4-12</p> <p>Mean age: 7.4 years</p> <p>Gender: 27 male, 3 female</p> <p>Inclusion criteria: 1. primary school age (4 to 12 years) 2. attending one of the</p>	n= 30	<p>Name of the intervention: Sensory activity schedule</p> <p>Description: Sensory processing interventions include assessment for atypical sensory processing and tailored intervention to the child considering the educational needs. Teachers who deliver the intervention, are</p>	unclear	1. The PRPP Stage Two Cognitive Task Analysis (Chapparo and Ranka 2011)	Quasi-Experimental	8/9	Analysis of students' overall cognitive performance as measured by PRPP Stage Two total scores revealed that while students in both groups improved in their classroom cognitive strategy use, students in the SAS group improved more (median change score 12.11%) than students who received usual classroom teaching only (median change score 3.75%). This result was statistically significant

	<p>participating autismspecific schools</p> <p>3. in a class with a teacher who agreed to participate in the study</p> <p>4. diagnosis of autism confirmed</p> <p>5. evidence of sensory processing difficulties that negatively affected school performance as determined by classroom teacher and school occupational therapist by school records</p> <p>Clinical characteristics: Autism</p>		<p>consulted and trained in its use.</p> <p>Comparison: usual classroom teaching group</p> <p>Setting: school</p> <p>Length of session: 10 minutes</p> <p>Number of sessions: everyday before class for ten weeks</p> <p>Total session hours: unclear</p> <p>Group size: 13 intervention group, 17 control group</p> <p>Intervention deliverers: teachers (trained by occupational therapists)</p>				<p>(p=.02), with a medium to large effect size.</p>
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	Spectrum Disorder							
	Country: Australia							
Virone, M. 2021	Age range: 11–14 years Mean age: 12 years Gender: 3 male, 9 female Inclusion criteria: unclear Clinical characteristics: ADHD Country: USA	n= 8	Name of the intervention: The Mindfulness Project Description: Mindfulness interventions included deep breathing, body scans, sensory awareness, creative expression, psychoeducation, and homework Comparison: - Setting: school Length of session: 45 minutes Number of sessions: twice per week during an academic support period at the	Dialectical Behavioral Therapy model	1. BRIEF-2 Adolescent Self Score Report (Gioia et. al 2015)	Quasi-Experimental	6/9	The BRIEF-2 results indicated meaningful changes in the inhibit and emotional regulation subtests among the majority of participants (p=.20).

			beginning of the school day, total 12 sessions Total session hours: 12 Group size: 9 Intervention deliverers: occupational therapist						
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Table 3. Scores of risk of bias assessment

Quasi-Experimental Studies*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	Questions:
Chaimaha 2017	+	+	+	+	+	+	+	+	+	1. Is it clear in the study what is the 'cause' and what is the 'effect'?
Cheung 2018	+	+	+	-	+	-	?	+	+	2. Were the participants included in any comparisons similar?
Cheung 2021	+	+	+	+	+	+	?	+	+	3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?
Garg 2013	-	+	?	-	+	+	+	+	+	4. Was there a control group?
Hample 2020	+	+	-	-	+	+	+	+	-	5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?
Koenig 2021	+	+	+	+	+	-	+	+	-	6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?
Leinfuss 2021	?	+	?	+	+	+	+	?	+	7. Were the outcomes of participants included in any comparisons measured in the same way?
Mills 2021	+	+	+	+	+	-	+	+	+	8. Were outcomes measured in a reliable way?
Onwumere 2020	+	+	+	-	+	+	+	+	+	9. Was appropriate statistical analysis used?
Pierce 2020	+	+	?	-	+	+	+	+	+	
Virone 2021	+	+	+	-	+	+	+	-	?	

*Based on critical appraisal tool for Randomised Controlled Trials and Quasi-Experimental Studies from Joanna Briggs Institute (JBI 2020)

- + low risk
- high risk
- ? unclear risk

Randomized Controlled Trials*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Buckle 2011	+	+	+	?	-	-	+	+	-	+	+	+	+
Janeslätt 2014	+	-	+	?	-	?	?	+	-	+	+	+	+

Questions:

1. Was true randomization used for assignment of participants to treatment groups? 2. Was allocation to treatment groups concealed? 3. Were treatment groups similar at the baseline? 4. Were participants blind to treatment assignment? 5. Were those delivering treatment blind to treatment assignment? 6. Were outcomes assessors blind to treatment assignment? 7. Were treatment groups treated identically other than the intervention of interest? 8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed? 9. Were participants analyzed in the groups to which they were randomized? 10. Were outcomes measured in the same way for treatment groups? 11. Were outcomes measured in a reliable way? 12. Was appropriate statistical analysis used? 13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?

Table 4. *Main outcomes and findings in ADHD children's' school-based occupational therapy interventions*

References	Main outcomes in school skills and abilities	Main findings
Buckle et. al 2011	Process skills: <ul style="list-style-type: none"> • Task completion speed • Attention-to-task • In-seat behaviour 	<ul style="list-style-type: none"> • Evidence of this study suggests that learners diagnosed with ADHD have improved their in-seat behaviour and attention-to-task while wearing weighted vests in a school context • Future research may be directed to developing a standardised protocol for the use of weighted vests in terms of duration of use, amount of weight used and type of activities for which they are suitable
Chaimaha et. al 2017	Cognitive abilities: <ul style="list-style-type: none"> • Working memory, planning and monitoring 	<ul style="list-style-type: none"> • The results supported that therapeutic programs were effective in improving working memory, planning, and self-monitoring functions for students with ADHD with EFDs • Study encouraged parents, teachers and peers to participate in the collaborative program to support ADHD children with EFDs in various contexts
Virone et. al 2021	Social interaction skills: <ul style="list-style-type: none"> • Emotional control • Impulse control 	<ul style="list-style-type: none"> • Findings suggest that mindfulness as a valid intervention for adolescents with ADHD by improving emotional regulation and impulse control • Teaching students strategies to manage emotions and impulses can improve responses during stressful situations

Table 5. *Main outcomes and findings in ASD children's' school-based occupational therapy interventions*

References	Main outcomes in school skills and abilities	Main findings
Cheung et. al 2018	Social interaction skills: <ul style="list-style-type: none"> • Increased knowledge of social skills • Social behaviour 	<ul style="list-style-type: none"> • The social-cognitive intervention program was found to have positive impact on the adolescent participants in ToM, but without a control group, the improvements and benefits reported cannot be objectively measured
Cheung et. al 2021	Social interaction skills: <ul style="list-style-type: none"> • Parent-perceived changes in children's social abilities and skills in multiple settings 	<ul style="list-style-type: none"> • The improvements in the social skills and ToM measures in the intervention group of children were consistent with the results indicated by the GAS score findings • Children's improvements in social skills and conversation skills were noted across different contexts, including in the home, at school, and in community settings
Onwumere et. al 2021	Social interaction skills: <ul style="list-style-type: none"> • Self-regulation • Self-determination Process skills: <ul style="list-style-type: none"> • Executive functioning 	<ul style="list-style-type: none"> • Instruction in self-determination, executive function, and self-regulation strategies using the Independent Curriculum (IC) can increase goal attainment and promote functional independence in middle school autistic students
Koenig et. al 2012	Social interaction skills <ul style="list-style-type: none"> • Maladaptive behaviour 	<ul style="list-style-type: none"> • The intervention group showed a reduction in behaviours that were identified as maladaptive by teachers, including irritability, lethargy, social withdrawal, hyperactivity, and noncompliance

Garg et. al 2013	<p>Social interaction skills:</p> <ul style="list-style-type: none"> • Self-regulation <p>Process skills:</p> <ul style="list-style-type: none"> • Level of independence, attention, transition from one activity to another 	<ul style="list-style-type: none"> • Students demonstrated a statistically significant improvement on all four classroom behaviours • Special education teachers reported improvements in the overall structure and transition periods throughout the day as well as the improvements in overall class functioning when using this program
Pierce et. al 2020	<p>Social interaction skills:</p> <ul style="list-style-type: none"> • Self-determination <p>Functional life skills:</p> <ul style="list-style-type: none"> • Home and family, employment/education, leisure pursuits, community involvement, emotional and physical health, and personal responsibility and relationships 	<ul style="list-style-type: none"> • Students receiving services developed functional behaviors at a higher rate than what might have been expected from maturation • Occupational therapy personnel could assist school districts in meeting federal expectations that students are equipped to attain satisfying and productive adult lives following graduation
Leinfuss et. al 2021	<p>Process skills:</p> <ul style="list-style-type: none"> • Process skills in the context of everyday life 	<ul style="list-style-type: none"> • Statistically significant change in occupational performance in the intervention group, which received Ready to Learn and Play-intervention in addition to their OT program

	<p>Sensory abilities:</p> <ul style="list-style-type: none"> • Sensory processing patterns 	<ul style="list-style-type: none"> • The improvements noted in processing skills point to the functional implications of learning sensory regulation strategies on occupational performance
Hample et. al 2020	<p>Sensory abilities:</p> <ul style="list-style-type: none"> • Interoception awareness 	<ul style="list-style-type: none"> • Postintervention data revealed significant improvement which provides preliminary evidence that interoceptive awareness may have improved during the intervention • Improving interoceptive awareness may translate into gains in emotional regulation and performance in relevant occupations of ASD children
Janeslätt et. al 2014	<p>Cognitive abilities:</p> <ul style="list-style-type: none"> • Time processing ability • Managing one's time 	<ul style="list-style-type: none"> • Time-processing ability can be improved by intervention using time aids in children with intellectual and developmental disabilities • Study needs further replication to ensure consistency of the findings
Mills et. al 2021	<p>Cognitive abilities:</p> <ul style="list-style-type: none"> • Use of cognitive strategies 	<ul style="list-style-type: none"> • Cognitive strategy items targeting attention, sensory perception, and planning showed significantly more improvement in the Sensory Activity Schedule group • When suitable students are given the opportunity to access sensory opportunities and adjustments within their own context, it can have a positive impact on classroom cognitive strategy use during participation in classroom occupations