



Development and Further Content Validation of the Motivation Assessment Tool for Physical Activity (MATPA) Among Children with Autism Spectrum Disorder

Mi An¹ · Takehiro Sasai¹ · Ryotaro Ito¹ · Mayumi Inoue¹ · Misa Komaki¹ · Yusuke Kusano¹ · Ami Tabata¹ · Farid Bardid² · Katie Fitton Davies³ · Lawrence Foweather³ · Zoe Knowles³ · Simon J. Roberts³ · James Rudd⁴ · Toshihiro Kato⁵

Accepted: 30 March 2025

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2025

Abstract

This study describes the content validity process, focusing on children, to create and validate a tool for assessing motivation toward out-of-school physical activity (PA) among children with autism spectrum disorder (ASD) aged 6 to 17 years. Additionally, it establishes the eligible verbal communication age range necessary for its application. The initial development and content validity process with external experts is described elsewhere (An et al., 2025 under review). The MAT-PA was iteratively refined during the content validity process with twenty children (two with version 0.1, ten with version 0.2, and eight with version 0.3). Modifications were made based on feedback from children who completed the entire interview. The Vineland Adaptive Behavior Scales, Second Edition (VABS-2), assessed the age-equivalent for daily verbal communication skills required for the MAT-PA. Feedback from the twelve children who completed the entire interview process (two with version 0.1, six with version 0.2, and four with version 0.3) provided evidence supporting the tool's content validity. Challenges with attention spans and verbal abilities limited full participation from the remaining eight children. Parent-reported VABS-2 scores indicated that the MAT-PA is suitable for children with ASD who have verbal communication skills equivalent to 3-year-olds (receptive) and 6-year-olds (expressive). The MAT-PA is the first tool specifically designed to explore the psychological needs and behavioral regulation of children with ASD, providing evidence of content validity. Future work should focus on improving the tool's reliability for trial integration, exploring its applicability across diverse contexts, and leveraging technology to boost scalability and impact.

Keywords Self-Determination Theory · Out-of-school physical activity · Autism spectrum disorder · Children · Motivation · Assessment

Introduction

Core symptoms of children with autism spectrum disorder (ASD) include delayed social communication, and restricted, repetitive behaviors and interests (American Psychiatric Association, 2013). Along with these core symptoms, research indicates that children with ASD have a 41.1% greater risk of developing obesity and physical inactivity (Kahathuduwa et al., 2019). The (World Health Organization., 2020) advises that all children and adolescents aged 5–17 should engage in at least 60 min of moderate to vigorous physical activity (MVPA) daily. However, a meta-analysis (Abadi et al., 2023) reported that, in comparison to typically developing children, children with ASD engage in 30 min less of daily MVPA. Additionally,

✉ Mi An
nilo23452345@gmail.com

¹ Human Health Sciences, Graduate School of Medicine, Kyoto University, Kyoto, Japan

² Strathclyde Institute of Education, University of Strathclyde, Glasgow, UK

³ School of Sport and Exercise Sciences, Faculty of Science, Liverpool John Moores University, Liverpool, UK

⁴ Department of Teacher Education and Outdoor Studies, Norwegian School of Sport Sciences, Oslo, Norway

⁵ Faculty of Rehabilitation, Kansai Medical University, Osaka, Japan

only 42% of children and adolescents with ASD achieve the WHO's 60-min daily MVPA recommendation (Liang et al., 2020).

Being physically active has proven to be beneficial for the core symptoms of children and youth with ASD, including social challenges and stereotypes (Howells et al., 2019; Jiang et al., 2024; Sowa & Meulenbroek, 2012), as well as motor deficiencies, skill-related fitness, muscular strength, endurance (Healy et al., 2018), and mental health (Accardo et al., 2024). Whilst there is evidence calling for the need to encourage children with ASD to engage in more physical activity (PA), the 42% figure from Liang et al. (2020) may be an overestimation. According to Okkenhaug et al. (2024), physical activity is not a priority for many families with children with ASD due to various barriers worldwide, including intrapersonal, interpersonal, institutional, community, public policy, and physical barriers. Even when all non-intrapersonal barriers have been addressed in PA, a child without motivation cannot make a commitment to PA and will not benefit from participation in PA in the long-term. To increase the sustainability of PA programs or interventions for children with autism, it is therefore important to study motivation amongst them.

According to self-determination theory (SDT), contextual motivation drives engagement in different contexts (Vallebrand, 1997). Intrinsic motivation, which involves engaging in PA for its own sake rather than for external rewards or pressures (Ryan & Deci, 2020), is crucial for improving PA levels (de Bruijn et al., 2023). Understanding the motivational dynamics towards PA in children with ASD is essential, as self-determined motivation can influence long-term participation and promote overall health (Pan et al., 2011). One mini theory of SDT is Organismic Integration Theory (OIT) (Deci & Ryan, 1985b) which identifies four types of extrinsic motivation based on internalization: external regulation (driven by rewards or the avoidance of punishment), introjected regulation (driven by self-esteem for success or by avoidance of anxiety, shame, or guilt for failure), identified regulation (driven by personally endorsing the value of an activity), and integrated regulation (fully aligned with self-concept) (Ryan & Deci, 2020). These, along with amotivation (lack of intention) and intrinsic motivation (driven by inherent interest), form a continuum of motivation.

Another mini theory of SDT- Basic Psychological Needs Theory (BPNT) (Deci & Ryan, 1985a; Ryan & Deci, 2017) suggests that fulfilling autonomy, relatedness, and competence needs enhances intrinsic motivation in various contexts, including PA, which is crucial for well-being (Fraguela-Vale et al., 2020). Autonomy is the need to feel that one has choice and willingly endorsing one's behaviour; Competence is the need to produce desired outcomes and to experience mastery; Relatedness is the need to feel connected and belongingness with others (Deci & Ryan, 2000).

The need for autonomy in OIT reflects self-determinism and the internalization of extrinsic motivation (Deci & Ryan, 1985b). To foster intrinsic (self-determined) motivation in PA, and well-being among children, the needs for autonomy, competence, and relatedness must be met within the social environment. If children's need satisfaction and their primary motivational regulations are understood, it is possible to better understand, motivationally, their PA environments and create informed interventions for them. A scoping review (Wong et al., 2024) on motivational factors influencing participation in structured PA indicates that meeting the psychological needs of autistic children and youth supports self-determined motivation, although fulfilling these needs may differ from those of their neurotypical peers. Unsurprisingly, only one study by Pan et al. (2011), included in Wong et al. (2024)'s review, used the motivation assessment tool to measure motivation. Along with all the studies included by Wong et al. (2024), the current literature (Block et al., 2022) **acknowledges the importance of motivation in interventions, but few have attempted to make this concept measurable.**

To understand the contextual motivation for PA amongst children with ASD and address their unique needs, appropriate measurement tools are necessary. However, the only existing motivation assessment tool for PA in children with ASD is that of a motivation scale designed for 13- to 16-year-olds within physical education (PE) classes (Ntoumanis, 2001; Pan et al., 2011). Pan et al. (2011) uses a 7-point Likert scale to measure motivation for PE but does not explore the underlying reasons behind these choices, which is crucial given the unique characteristics of ASD. Another limitation is that the target group consists of adolescents with ASD ($M \text{ age} = 14.26 \pm 0.89 \text{ years}$), who are more likely to complete the Likert scale than younger children. However, no other information regarding the children's adaptive function, mental age, or reading/writing skills was provided. There are no valid and reliable assessments for measuring motivation in out-of-school PA contexts (e.g., daily play, exercise, sports) that cover a broader age range, including younger children (Sebire et al., 2013). PA involves people moving, acting, and performing within culturally specific spaces and contexts, and influenced by a unique array of interests, emotions, ideas, instructions, and relationships (Piggin, 2020). Since motivation for PA can differ outside of compulsory school settings (Brooke et al., 2014; To et al., 2022) and adolescents with intellectual and developmental disabilities display different PA patterns during non-school hours (Helsel et al., 2024), a tool that assesses motivation for out-of-school PA throughout childhood and adolescence is needed.

As a response to the need for an appropriate tool, specifically designed for children with ASD, the Motivation Assessment Tool for Physical Activity

(MAT-PA) was recently adapted from the Motivation Assessment Tool for Physical Education (Davies et al., 2021)—a tool deemed more viable for children with ASD, and its initial content validity was confirmed by external experts (An et al., 2025 under review). It is designed for use with children with ASD, aged 6 to 17 years, in Japan, to assess their contextual motivation toward out-of-school PA. Out-of-school PA is categorized by mode, setting, and type (Eime et al., 2013), reflecting its complexity as children often participate in multiple PA modes (team sport, individual sport, organized non-competitive activities, and non-organized activities) and settings (facility-based or neighbourhood-based) for a single type of PA (Eime et al., 2016). The results of the survey from The National Sports-Life of Children and Young People (Sasakawa Sports Foundation, 2021, 2023) and the most frequently reported regular activities among adolescents with ASD from a study by Stanish et al. (2017) were used to identify the 13 types of PA—tag, rope jumping, swinging, hide and seek, soccer, badminton, basketball, table tennis, swimming, walking, running/jogging, bicycling, and exergaming—that are frequently carried out in Japan by children with ASD, as included in MAT-PA.

MAT-PA is underpinned by SDT, specifically two of its mini theories (Deci & Ryan, 1985a, 1985b; Ryan & Deci, 2017), and comprises of interactive, picture-based activities that are autism-friendly, and was designed to explore children's satisfaction of three psychological needs (autonomy, competence, and relatedness) in PA and the motivation (behavioral regulation) related to actions that drive their out-of-school PA behaviors. The newly developed MAT-PA addresses gaps in the motivation assessment tool literature (Ntoumanis, 2001; Pan et al., 2011; Sebire et al., 2013) by transitioning from a Likert-scale to pictorial, activity-based interviews, expanding the age range to include younger children, and focusing on out-of-school contexts, with expert validation involved. There is currently very limited literature (Li et al., 2023) on involving children with ASD in finalizing an assessment tool for themselves, let alone engaging them in a rigorous validation process. **This study aimed to determine if the tool's target children understood the MAT-PA picture resources, instructions, items, response options, and recall period, and to improve it.** Specifically, five research questions were listed to explore whether children (1) interpreted the pictures as intended, (2) understood the interview wording, (3) comprehended the activity types and response options, (4) could provide appropriate responses to different activities, and (5) could recall experiences from the past 12 months. Additionally, the study aimed to assess the appropriate age range for the daily verbal communication skills needed to use MAT-PA, to clearly determine which children with ASD can use the tool.

Methods

The tool development was conducted through multiple phases, two of which were administered concurrently, and presented within two separate studies (see Table 1). As shown in Table 1, the initial development of MAT-PA (version 0.1) and content validity testing with external experts (which led to version 0.2) have been completed (An et al., 2025 under review). The current study provides details on the content validity testing of MAT-PA (versions 0.1, 0.2, and 0.3) with children with ASD, leading to the final version of MAT-PA.

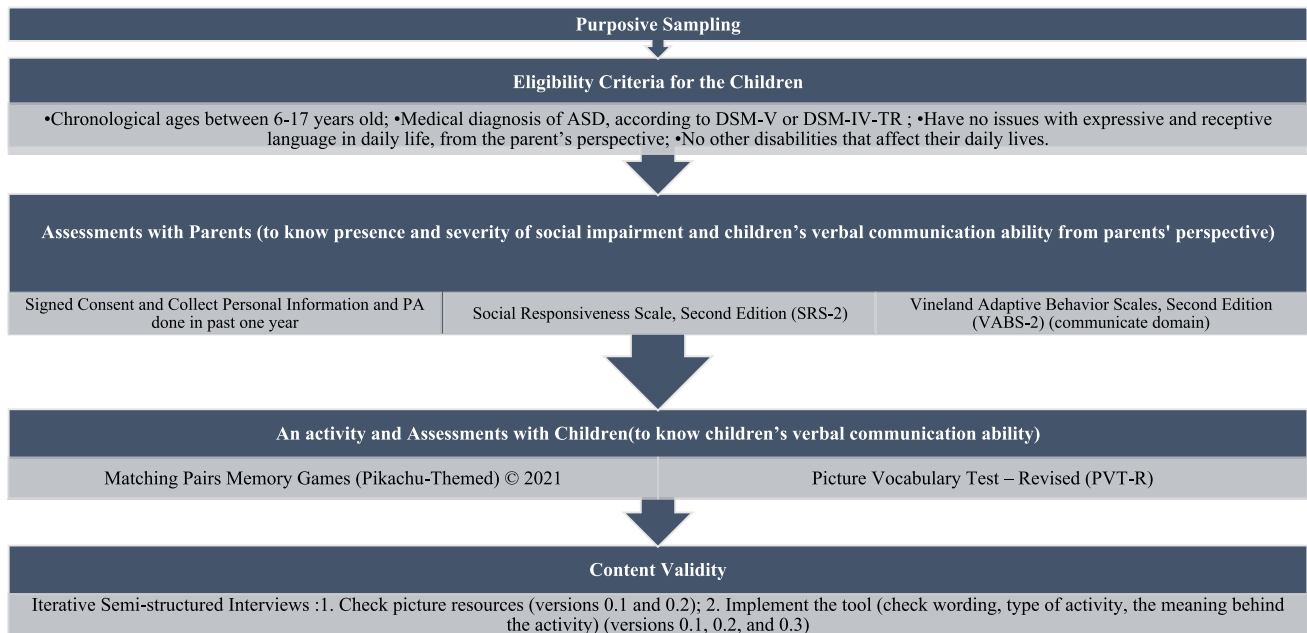
Although the MAT-PA demonstrated good content validity with external experts, adapting it for a new population and context requires assessing content validity with the target population (Mokkink et al., 2010). Content validity refers to the degree to which the content of an instrument accurately reflects the construct being measured (Mokkink et al., 2010). It encompasses three key aspects: (1) relevance: all items should be pertinent to the construct of interest within a specific population and context of use; (2) comprehensiveness: no key aspects of the construct should be missing; and (3) comprehensibility: the items should be clearly understood by the user as intended. Given that the target population consists of children, the MAT-PA was finalized by evaluating its comprehensibility (but not its relevance and comprehensiveness) with children using different versions of MAT-PA (see Table 1). Content validity was evaluated through semi-structured cognitive interviews with children with ASD, following the CONsensus-based Standards for the selection of health Measurement Instruments (COSMIN) guidelines (Terwee et al., 2018). Figure 1 shows the procedures for content validity. Each section is explained with details below. This study was approved by the university's graduate school of medicine and its ethics committee (protocol number: R4063-3).

Recruitment and Eligibility Criteria

Families (parents and children) were recruited by the authors, who asked school principals and special education teachers to deliver a one-page A4-size recruitment poster to parents of children attending special education classrooms in mainstream elementary, middle, and high schools, either online or in person, in Osaka and Kyoto cities (Kansai area, known as a densely populated area in Japan). Recruitment also took place by delivering the poster to after-school day care centers and parent associations for ASD through in-person sessions and emails, with the permission and assistance of the directors

Table 1 Indicative content of MAT-PA development and current study focus

Another study by An et al., under review—Initial process: initial tool development and content validity with experts		Current study-content validity process with children
Phase 1 (Development)	Phase 2 (Content validity)	Concurrent Phase of Phase 2 (Content validity)
Aim: To adapt the MAT-PA from the MAT-PE	Aim: To ascertain content validity (relevance and comprehensiveness) of the MAT-PA with seven external experts	Aim: To ascertain initial face validity of the MAT-PA (version 0.1) with two children
Findings: Development of the MAT-PA (version 0.1)	Findings: The MAT-PA version demonstrated promising content validity The production of the MAT-PA (version 0.2)	Findings: The production of the MAT-PA(version 0.2) Next step: the ascertain content validity from more children with ASD
Next step: To ascertain initial content validity	Next step: To ascertain content validity from children with ASD	Phase 3 (Content validity)
		Aim: To ascertain content validity of the MAT-PA (version 0.2) with ten children and the content validity of the MAT-PA (version 0.3) with eight children To produce a final version of the MAT-PA based on feedback from children with ASD Findings: The production of the MAT-PA (final version)

**Fig. 1** Procedures for content validity with children

or heads of the facilities in the Kansai area and Kagoshima Prefecture (rural areas in Japan). Families in the Kansai area who took part in the study at an earlier stage would recommend acquaintances who potentially met our eligibility criteria by sharing the poster. Overall, purposive sampling strategies, including maximum variation

sampling, criterion-based sampling, and snowball sampling, were used to ensure that the study included children with diverse age ranges, and both genders. The recruitment lasted from November 2023 to March 2024. Parents who were interested in participating and believed their children met the eligibility criteria sent an email to

the first author, who double-checked the eligibility criteria and arranged a day to explain the research purpose. On the same day that the research purpose was explained, either online or in person, and after the parents gave consent to the study, data collection with the parents began. On another day, as agreed upon by the first author and the parents, the interview was arranged at the child's school, the after-school day care, or the university where the first author is based.

Children were eligible to participate if they (1) have a medical diagnosis of ASD according to DSM-5 or DSM-IVTR (Pervasive Developmental Disorders, Autistic Disorder, Asperger's Disorder), (2) are aged 6–17 years, (3) have no issues with expressive and receptive language in daily life, from the parent's perspective, and (4) have no other disabilities that affect activities of daily living.

Parents as Participants

The first author met with each parent separately for approximately one hour to obtain signed informed consent and gather demographic information. Parents completed the Social Responsiveness Scale, Second Edition (SRS-2) (Constantino et al., 2017) and participated in a brief interview using the Vineland Adaptive Behavior Scales, Second Edition (VABS-2) (communication domain) (Sparrow et al., 2014) to assess their child's receptive and expressive language skills. Children with limited expressive language were included to determine the minimum age equivalent for future potential participants, as "limited expressive language" was not clearly defined during the children's developmental stage and can change and improve over time. Interviews took place on separate days in a quiet room with the presence of a parent or teacher. For those unable to meet in person, assessments and documents were sent by post, and interviews were conducted online.

Measures with Parents

The demographic information asked parents to provide their name, their child's name, the child's sex, date of birth, diagnosis and the year it was made, the school the child attended, and the PAs the child has typically engaged in outside of school over the past 12 months. This information served as a reference to help remind children of the activities they have been doing if they have trouble recalling them during the interview.

Social Responsiveness Scale, Second Edition (SRS-2), Japanese version (Constantino et al., 2017) is a parent written questionnaire that assesses the characteristics of ASD, such as interpersonal behavior, communication, and repetitive/addictive behaviors, for children from 2.5 years old to adults. The psychometric properties of the Japanese

version have been previously validated with Japanese children (SRS-2 for school-age: internal consistency $\alpha > 0.918$) and Japanese children with ASD (SRS-2 for school-age: internal consistency $\alpha > 0.95$; test–retest reliability 0.96) (Constantino et al., 2017). SRS-2 was used to identify the severity of social impairment in children with ASD in this study.

The Vineland Adaptive Behavior Scales, Second Edition (VABS-2), Japanese version (Sparrow et al., 2014) evaluates adaptive behavior (ability to perform daily activities necessary for personal or social fulfillment) in individuals from birth to 92 years through semi-structured interviews. It includes four primary domains and optional maladaptive behavior domains. For the VABS-2, the standardized Japanese version shows overall adequate internal consistency ($\alpha > 0.7$) and test–retest reliability (0.8) (Sparrow et al., 2014). This study focused on the receptive and expressive language subtests to assess the child's verbal communication abilities.

Children as Participants

All children met with the first author in person. Informed assent was obtained from those aged 7–15, in accordance with the Graduate School Ethical Committee guidelines (in Japanese) (Ministry of Education et al., 2021). All parents and children aged 16 or older gave informed consent. Additionally, informed assent was obtained from children aged 7 to 15 who were capable of expressing their own will. Children younger than 7 years of age did not sign informed assent, but their parents provided informed consent. To help children relax, a Pokémon™ Pikachu-themed memory game with 24 cards (12 pairs) was used as an icebreaker or intermission. Prior to the interviews, the Picture Vocabulary Test-Revised (PVT-R) (Ueno et al., 2008) was administered to assess expressive vocabulary age equivalents. Children with limited expressive vocabulary were not excluded; the age equivalents from PVT-R and VABS-2 served as measurements, not eligibility criteria, to determine the acceptable age range for the MAT-PA target population.

Measures with Children

The Picture Vocabulary Test- Revised (PVT-R), Japanese version (Ueno et al., 2008), is a localized version of the Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981) for Japanese language users (internal consistency: 0.98; test–retest reliability: 0.86). It is a developmental test that quickly assesses receptive vocabulary ability in children between the ages of 3 years and 12 years and 3 months. The assessment requires the child to select the picture that best represents the word spoken by the examiner from several options.

MAT-PA Content Validity with Children

An interview guide, available in English and Japanese, detailed the instructions, questions, sequence. One of the child's parents or teachers was invited to join if they were willing. As shown in Fig. 1, content validity with children consists of two parts: checking picture resources and implementing the MAT-PA. When testing with versions 0.1 and 0.2, children were asked about the pictures first, and then the first author conducted the MAT-PA with them. During testing with version 0.3, the first author purposely skipped the pictorial resources assessments and conducted the MAT-PA directly. Version 0.3 is the latest version, leading toward the final version. The authors noted that the pictures, which were improved from version 0.2 to version 0.3, were deemed clear enough (with simple word descriptions) for the children to comprehend.

In pictorial resources assessments, children were asked to verbalize their thoughts while responding to an open-ended question about the pictures. The interviewer explained the process, emphasizing that there were no right or wrong answers, and used prompts such as, "What is happening in this picture?" Additional prompting questions included, "Can you identify any differences between these two pictures?" If a child took longer than expected to respond, the interviewer reassured them by saying, "If you're unsure about what's happening in the picture, it's okay to say that you don't know." Two children were administered version 0.1, ten additional children were administered version 0.2 and tested on the pictorial resource, while the remaining children who were administered version 0.3 were not administered the pictorial resources.

The MAT-PA (different versions) was conducted with twenty children with ASD. The MAT-PA (version 0.1) was administered to two children to determine initial face validity. Expert input and feedback from these children led to the development of version 0.2. An additional ten children were then administered the MAT-PA (version 0.2), which led to the creation of version 0.3. This was followed by a different group of eight children who were administered the MAT-PA (version 0.3), resulting in the final version. The sample size for versions 0.2 and version 0.3 were determined according to the COSMIN guidelines (Terwee et al., 2018), which recommend 4–6 participants as being typically sufficient, with more than 7 participants considered "very good" for assessing the comprehensibility of a measurement instrument. Consequently, ten participants were included in version 0.2 and eight participants in version 0.3, due to participant availability and the possibility of dropout.

The entire process was recorded using high-quality audio and transcribed verbatim. Children's narrative responses were reviewed by two coders (postgraduate

students) to ensure alignment with the research questions and intended constructs. For controversial items, such as questions where 50% of responses are in one direction and 50% in the opposite, the authors discussed whether to redesign the material if responses did not match the intended purpose. For the pictures, if it was feasible to enhance understanding by adding accompanying words to the pictures, the authors decided not to redraw them.

Results

Sample Characteristics

Demographics and Completion Rates

Twenty children aged between 6 and 17 years (mean chronological age at the first assessment = 11 years 6 months; 65% boys) were recruited. Two children participated in the interview using MAT-PA (version 0.1). An additional ten children were interviewed using MAT-PA (version 0.2). At the final stage, eight were interviewed using MAT-PA (version 0.3). No families withdrew from the assessments or the interviews. All parents filled in the demographic information, completed the SRS-2 and received VABS-2 semi-structure interviews, and all children completed the PTV-R and attended the interview. However, attributed to short attention spans and variations in verbal abilities, two, six, and four children respectively completed the entire interview for versions 0.1, 0.2 and 0.3. Overall, twelve out of twenty children (60%) were assessed with the entire MAT-PA. The picture resources assessment was simple and came first. Despite challenges with attention spans and verbal abilities, all twelve children who were administered versions 0.1 and 0.2 gave their responses to the picture resources. However, data for child 12 was not included/analysed because the result for the SRS-2 was normal. Overall, eleven children provided responses to the pictorial resources.

Summary of SRS-2, PVT-R and VABS-2 Scores for Twenty Children

The total T-score for SRS-2 ranged from 44 (normal) to higher than 90 (severe). The raw score (age equivalent) for receptive subdomain and expressive subdomain ranged from 2 years 11 months to 7 years 5 months, 2 years 7 months to 7 years 10 months respectively. The expressive vocabulary age equivalent for PVT-R ranged from 3 years to older than 12 years 3 months. The data on verbal abilities from the VABS-2 and PVT-R were compared. While the VABS-2 covers more comprehensive aspects

of verbal communication skills, the expressive vocabulary age equivalent from the PVT-R has limitations and does not fully reflect the child's overall verbal abilities. Thus, the PVT-R score had not been used to determine the eligible age equivalent range for the daily verbal communication abilities required for MAT-PA's use. The characteristics of the children and their involvement in the testing with different versions are presented in Table 2.

Summary of SRS-2 and VABS-2 Scores for Twelve Children

All twelve children (two using version 0.1, six using version 0.2, and four using version 0.3) completed the entire interview, and the data are summarised for them (mean chronological age at the first assessment = 12 years 11 months; mean expressive age equivalent = 6 years 7 months, mean receptive age equivalent = 4 years 9 months, 67% boys). The total T-score on SRS-2 ranged from 63 (mild) to higher than 90 (severe). The raw score (age equivalent) for receptive subdomain and expressive subdomain on VABS-2 ranged from 2 years 9 months to 7 years 5 months, 5 years 4 months to 7 years 10 months respectively. It was assumed that if a child has the same receptive or expressive age as that of a 5- to 6-year-old, they should be able to use MAT-PA (Davies et al., 2021). *Expressive age:* By checking the expressive age column in Table 2, most children who completed the interview have a minimum age of 5 years and 4 months. However, not all children with an expressive age older than 5 years and 4 months completed the entire interview (e.g., exceptions are child 15 and child 17). Alternatively, if the expressive age is *around 6 years*, then the child should be able to complete the entire interview. *Receptive Age:* Despite having an expressive age equivalent to that of a 5- to 6-year-old, six out of twelve children (50%) had a relatively low receptive age equivalent of *around 3 years old* (e.g., child 4, child 7, child 9, child 10, child 14, and child 20) when compared to the other children in this study. Overall, the receptive age equivalent was low, but pictorial resources are believed to be helpful in improving children's understanding of the interview questions and prompts, regardless of their receptive age equivalent.

Description of the MAT-PA (Final Version)

Figure 2 provides an overview of the MAT-PA (final version). Supplementary information provides an updated description (including purpose, theoretical framework, and constructs) of the MAT-PA and shows how the authors improved the tools from the older versions to the new one. The MAT-PA (final version) requires about 45–60 min to administer (not including the resting time and the time for PVT-R). The authors deemed the tool comprehensible, as the activities were deemed familiar and easily understood by

the children, effectively addressing five research questions related to content validity (comprehensibility) about picture resources, instructions, items, response options, recall period. Thus, adhering to COSMIN guidelines, the authors concluded that the tool demonstrated good content validity. Furthermore, based on evidence from the VABS-2 (communication domains) for all twenty children, MAT-PA was deemed suitable for use with children with ASD whose verbal communication skills are equivalent to those of 3-year-olds (receptive) and 6-year-olds (expressive), though some exceptions were noted.

Discussions

This study reports on the development and further content validity of the MAT-PA among children with ASD. While the tool's relevance and comprehensiveness have been confirmed by external experts (An et al., 2025 under review), this study focuses on its content validity, particularly its comprehensibility, as evaluated with twenty children with ASD. Their feedback led to revisions across versions 0.1, 0.2, 0.3, and the final version, demonstrating that the MAT-PA has promising content validity in terms of comprehensibility. Furthermore, the MAT-PA was determined to be suitable for use with children with ASD who have verbal communication skills comparable to those of 3-year-olds (receptive) and 6-year-olds (expressive). The discussion section is divided into two parts as follows: the first addresses the overall framework and the five research questions related to content validity, with a separate discussion on the appropriate age equivalent included in the limitations. The second part provides a general discussion focusing on the strengths of the newly developed tool, MAT-PA, in comparison with existing motivation tools for PA.

Children's Feedback and Modifications

Children's responses during semi-structured interviews provided new insights, leading the authors to reconceptualize the definition of out-of-school PA, which had previously not included housework. Three children (e.g., child 2, child 7, and child 8) mentioned engaging in various housework activities outside of school, such as grocery shopping, lining up shoes, and harvesting food from gardens. A study by Klein et al. (2009) revealed that children within Los Angeles spent surprisingly little time on household work, whereas those in families with access to paid domestic help tend to be less helpful than those in families without. Additionally, children in White US middle-class families do not do enough housework (Sarmiento et al., 2024). In contrast, since there is typically not much paid domestic help but

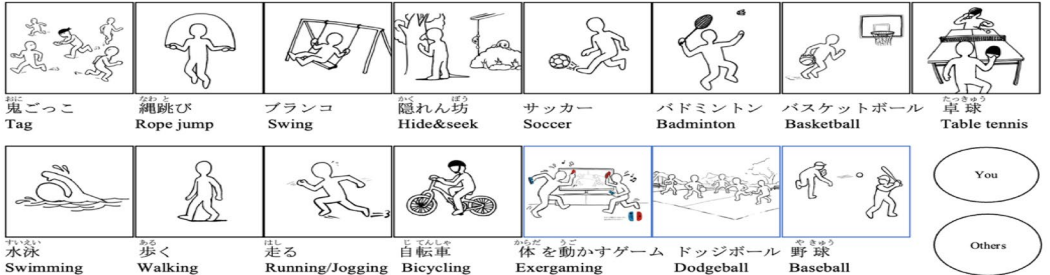
Construct & Activity Description	MAT-PA Resources (All activities completed one to one with the interviewer with the order from icebreaker to questions/stem 1 - 15.)	
Icebreaker: Pair matching card game	<Pictures for Pokémon™ Pikachu> A set of PA-themed cards is laid face-up before the child. The child is asked to remember the locations of all the matching pictures. When the cards are turned over, they can flip only the matching ones. The game concludes once all the matches are found. The child has the freedom to start with fewer or more pairs of cards. The format of the game can also be flexible: the child can play independently or compete with the interviewer.	
About out-of-school PAs (picking) How to explain the 'past year' to the child: Now it would be January. The past one year means from last January to this January. In terms of seasons, it would be from last winter to this spring, summer, fall, and winter.	 Question/Stem(s) "In your daily lives, you do PAs outside of school, don't you? First, please tell me what kind of PA (including active play or exercise) you have done/been doing within the past one year. Are there any PAs (active play or exercise) that you do among these 15 pictures? Please tell me by pointing out the pictures." (If the child does not do any of the PAs included in the 15 PAs provided here, we will ask the child to draw or write about them instead.) "Which of the following PAs (active play or exercise) do you do most often, tell us the top 3: in order from #1 to #3? Please point out and tell me."	
Autonomy Satisfaction (Sorting and discuss) The child is presented with two plates: 'You' (the child's plate) and 'Others' (Others' plate). Each child is shown a series of PA they have been engaged in out-of-school contexts and asked to sort them into whether they do because they want to or they do because of other reasons.	 Question/Stem(s) "I'm going to ask you about your PAs you do outside of school. Here're are some pictures of PAs (active play or exercise)" 1 "Among activities you have pointed out/drawn, which ones do you do because you want to, and which ones do you do because of other reasons?" (15 pictures of 15 types of PA will be shown) Probe(s) (Show the child each picture in "you" plate one at a time and ask the question.) "Can you tell me about a time you do this PA...?" / "When was the last time you did this PA?" "Where do you usually do this activity? With whom do you, do it? What tools do you use?" (Show the child each picture in "others" plate one at a time and ask the question.) Ask questions about particular PAs (top three) that the child do most often one by one. 2 "Can you decide the place you want to do these PAs?" "Can you always make the decision by yourself or sometimes?" 3 "Can you decide the people you want to play with in these PAs?" "Can you always make the decision by yourself or sometimes?" 4 "When participating in activities that use equipment (like balls, nets, beanbags, rackets), can you decide which equipment you want to use?" "Can you always make the decision by yourself or sometimes?"	

Fig. 2 An overview of the MAT-PA (final version): All the changes made versus version 0.1 were marked bold

occasionally home visits for childrearing (Yamaoka et al., 2024) in Japanese households (Nagase, 2024), chores involving mostly gross motor skills, such as helping with grocery

shopping and gardening, are newly added and classified as non-organized PA within MAT-PA.

The Hierarchical Model of Intrinsic and Extrinsic Motivation aims to understand individual motivation within their social contexts, showing its greatest value in

Competence Satisfaction (Choose and discuss)		
The child is presented with a series of PA and 1 to 5-star start-chart and is told by the question/stem 5.	Question/Stem(s) Probe(s)	
	“Here is a picture of the same 15 PAs we have showed you as before.” For PAs that the child has never done before, the interviewer would add a physical demonstration of the PAs to enhance the understanding towards those PAs. Then, ask whether the child would like to challenge themselves and how confident the child is in completing PAs he/she has never done before. 5 “A child who is very good at this PA would get five stars. A child who is good at this PA would get four stars. A child who is neither good nor bad at this PA would get three stars. A child is not good at this PA would get two stars. A child is bad at this PA would get one star. How many stars would you give yourself for doing things in PA?” (15 pictures of 15 types of PA will be shown one by one. ASK: How many stars you would give yourself for tag games...etc.?) “Why would you give yourself...star(s)?”	
Relatedness Satisfaction (Choose and discuss)		
The child is presented with two sets of cards: one set focused on the adults (family members or instructors/coaches) relationships and one set on peer (siblings and other friends) relationships.	Question/Stem(s) Probe(s)	
	“We have two pictures here of an adult and a child.” “Tell me about how you feel about adults when you engage in PAs with them. First, please think about all PAs in general, regardless of whether you are good/bad at them or not, or whether you have been doing it or not.” Then ask questions (relatedness with adults) for the particular PAs (top three) that the child do most often one by one. 6 “Child A feels safe and supported with adults in PA. Child B does not feel safe and supported with the adult in PA. Which child do you think you are most like? ” 7 “Child A feels relaxed and comfortable with adults in PA. Child B does not feel relaxed or comfortable with the adult in PA. Which child do you think you are most like?” “Why do you think so?” “Why do you think so?”	
Those adults are family members or instructors/coaches (in Japanese culture, the term teachers/staff is used) in a club or leisure center.	“We have two pictures here of other children and a child.” “Tell me about how you feel about your friends or peers when you engage in PAs with them. First, please think about all PAs in general, regardless of whether you are good/bad at them, or whether you have been doing it or not.” Then, ask questions (relatedness with peers/friends) for the particular PAs (top three) that the child do most often one by one. 8 “Child C feels like doing PAs with her/his friends/peers in PA; Child D does not feel like doing PAs with her/his friends/peers in PA; Which child do you think you are most like? ” 9 “Child C feels that being closer to other children after doing PA with her/his peers; Child D does not feel being closer to other children after doing PA with her peers; Which child do you think you are most like? ” “Why do you think so?” “Why do you think so?”	

Fig. 2 (continued)

these contextually situated perspectives (Vallerand, 1997), and out-of-school PA is a complex topic that encompasses a general context with many sub-contexts for different types of PAs. After discussing PA in general, the authors included additional discussions with children about the top three activities they engage in. This decision was made because interviews with children revealed that discussing specific

activities is more straightforward and simpler for them. This approach will provide detailed insights into the current PA environments, climates, and participation styles for the top three activities, and facilitate interviews with children. With this information, researchers, coaches, intervention implementers, and parents can better understand and

Behavioral Regulation Type (Choose, sort and discuss)

The child is presented with all the reasons why they might take part in PA: question/stem 10-15.

学校以外の時間で、		学校以外の時間で、		学校以外の時間で、		学校以外の時間で、		学校以外の時間で、		学校以外の時間で、	
楽しいから 体を動かす活動をする。		健康で強くなりたいから 体を動かす活動をする。		他の人に自分のことを良い子だと思ってもらって欲しいから 体を動かす活動をする。		何かもらえるかもしれないから 体を動かす活動をする。		他の人が体を動かす活動をさせているので、 体を動かす活動をする。		体を動かす理由は特にない。	
Question/Stem(s)						Probe(s)					
“There are several reasons why we do PAs. I will show you a picture at a time. Among all pictures I have shown, what are your favourite reasons that you are doing PAs? You could choose one or more than one. Please arrange them in order(only one card is allowed in each rank). Number one means the most important reason for you; number two means the second important one and so on.”											
10	“I do PA outside of school because PA is fun.”					Intrinsic: “Why is PA outside of school fun? ”/ “ What do you enjoy being physically active outside of school? ”					
11	“I do PA outside of school because I want to be healthy and strong.”					Identified: “Is being healthy and strong important to you? Why? ”					
12	“I do PA outside of school because I want others (my father and my mother or other adults in my household or other children)(usually Japanese do not have carers or helpers in the household) to think I am a good child . ”					Introjected: “Is it important that others to think you are a good child? Why?” “How would you feel if they do not think you were a good child? ”					
13	“I do PA outside of school because others might get me something . ”					External(reward): “What rewards do you get in PA outside of school? ” “ Outside of school , do you need to be good at PA to get a reward, or do you need to not mess around in PA to get a reward?” “Would you still want to do PA outside of school even if there was no reward for doing it? ”					
14	“I do PA outside of school because others make me do PA.”					External(punishment): “Do you feel like other people make you do PA outside of school even when you don't want to?” “If nobody would make you do PA outside of school , would you still want to do PA? ”					
15	“I don’t have any reason to do PA outside of school.”					Amotivation: “Why don’t you have any reason to do PA outside of school? ”					

Fig. 2 (continued)

improve participation in future activities, thereby supporting autonomy and relatedness needs.

Interpretation to picture resources (modifications see Figs. 2 and 3) For *autonomy and competence*, the picture of exergaming was not understood by all the children. Four children (e.g., child 1, child 6, child 8, child 9) drew “dodgeball” or “baseball” on extra sticky notes to indicate that they had been engaged in these activities over the past 12 months. Two new pictures for “dodgeball” and “baseball” were added. Modifications were made towards “exergaming”, highlighting the classic color (blue and red) of joy-con of the Nintendo Switch™ remote controls. Still, the game could be seen as either a dance exergame, a fitness exergame, or even both, depending on the child's interpretation and experience. The authors decided to retain both interpretations in the undeveloped codebook. For *relatedness*, all children had no problems in interpreting the pictures. For *behavioral regulations*, pictures for “introjected and external regulation (punishment)” were changed. The previous one for “introjected” did not include other

children and looked the same with the one for “relatedness with adults”, which made some children feel confused. The picture for “external punishment” was altered to appear gentler; the adult no longer looks angry but still conveys the message, “I do PA because others make me.” Although it represents “punishment”, adults in Japanese cultures, where conflicts are often avoided (Fuki, 2002), typically do not get angry if children do not participate in PA. In addition, some children were confused by the previous version of the picture. They thought the adults were patting the child on the head, whereas the intended meaning was to show the adults pointing at and scolding the child. Japanese captions are recommended for all pictures (see examples in Fig. 2) to provide further clarity.

Appropriateness of wording In version 0.1, two children did not understand the question, “Who gets to choose to do PA?” in the *autonomy* activity. Combined with expert suggestions, the question was revised in version 0.2 to ask if the children are doing PA they want to do. This revision was then validated with the remaining ten children. For

Table 2 Characteristics of Child Participants and Their Involvement in the Study (Ois added by the ID if the child finished the whole interview)

Face validity/Content validity							
Participants				SRS-2**	Vineland-2*** (receptive) Age equivalent	Vineland-2*** (expres- sive)Age equivalent	PVT- R****Age equivalent
ID	Chronological Age*	Sex	Diagnosis				
Children 1 and 2 were tested with version 0.1, and both completed the entire interview							
○ Child 1	9:0	Boy	ASD	88 Severe	4:6	6:11	8:10
○ Child 2	16:9	Boy	ASD	68 Moderate	7:5	6:6	12:3
Children 3 through 12 (a total of ten children) were tested with version 0.2. However, only children 4,6,7,8,9,and10 (six children) completed the entire interview							
○ Child 3	9:6	Boy	PDD	84 Severe	2:11	4:4	8:10
○ Child 4	9:3	Girl	ASD	63 Mild	3:8	5:4	8:1
○ Child 5	17:2	Girl	ASD	78 Severe	5:7	4:11	9:11
○ Child 6	16:11	Girl	ASD	63 Mild	7:5	7:4	12:3
○ Child 7	10:0	Boy	ASD, ADHD	82 Severe	3:11	6:6	9:9
○ Child 8	16:11	Boy	ASD, LD	66 Moderate	7:5	8:9	12:3
○ Child 9	9:3	Boy	ASD, ADHD	73 Moderate	3:4	7:4	11:10
○ Child10	15:0	Girl	ASD	86 Severe	3:11	7:10	12:3
○ Child 11	7:0	Boy	PDD	84 Severe	2:11	4:11	7:3
○ Child 12	6:7	Girl	ASD, DCD	44 Normal	3:11	5:1	6:10
Children 13 through 20 (a total of eight children) were tested with version 0.3. However, only children 14,16,19, and 20 (four children) completed the entire interview							
○ Child 13	10:1	Girl	PDD	73 Mild	3:11	5:1	9:2
○ Child14	14:8	Boy	ASD	83 Severe	3:8	5:4	11:4
○ Child 15	7:10	Boy	ASD	81 Severe	3:11	5:6	7:0
○ Child16	15:2	Boy	ASD	81 Severe	4:6	5:4	10:7
○ Child 17	8:10	Boy	ASD	81 Severe	2:11	5:11	6:10
○ Child 18	7:9	Boy	ASD	79 Severe	3:11	2:7	3: 0
○ Child19	16:5	Boy	ASD	> =90 Severe	4:6	7:4	12:3
○ Child 20	7:1	Girl	ASD	70 Mild	2:9	5:4	8:9
All previous process leads to the final version of MAT-PA							

*Child age at the first assessment. (Years and months)

**Social Responsiveness Scale Second Edition (SRS-2, Japanese version)

***Vineland Adaptive Behavior Scales Second Edition (VABS-2, Japanese version) (only communicate domains: covering receptive subdomain and expressive subdomain)

****Picture Vocabulary Test – Revised (PVT-R, Japanese version)

competence, “being good at” was used in our version 0.2 because some experts mentioned the importance of defining what “doing PA well” means. However, younger children (e.g., child 1, child 4, child 7, and child 20) had difficulty distinguishing between “being good at” and “having fun”; They would rate a PA with 4 or 5 stars if they enjoyed it, even if they were not good at it. In that case, the interviewer would reinforce differences and provide specific examples (e.g., “I like running but can’t run for more than ten minutes.”) to help the child re-evaluate. For *relatedness with adults*, the phrase “feeling safe and comfortable” was initially presented together in one sentence, which caused confusion. The questions were revised to two separate sentences: “feeling

safe and supported” and “feeling relaxed and comfortable” to improve clarity. For *relatedness with peers*, the phrases “feel like being with peers in PA” and “enjoying doing PA with peers” were combined into one question: “feel like doing PA with peers.” “Being with peers” may be misleading, as it can imply merely being in the same place without engaging in PA together. Additionally, a new question was added to assess whether children “feel closer to peers after doing PA with them,” referring to Ntoumanis (2001)’s tool. The ability to form good relations with others is viewed by the Japanese as a vitally important personality trait because they recognize that individual life is inextricably bound to group life (Kelly, 2001). Nakayoshi, means friendly

Figure 3 Revisions to picture resources

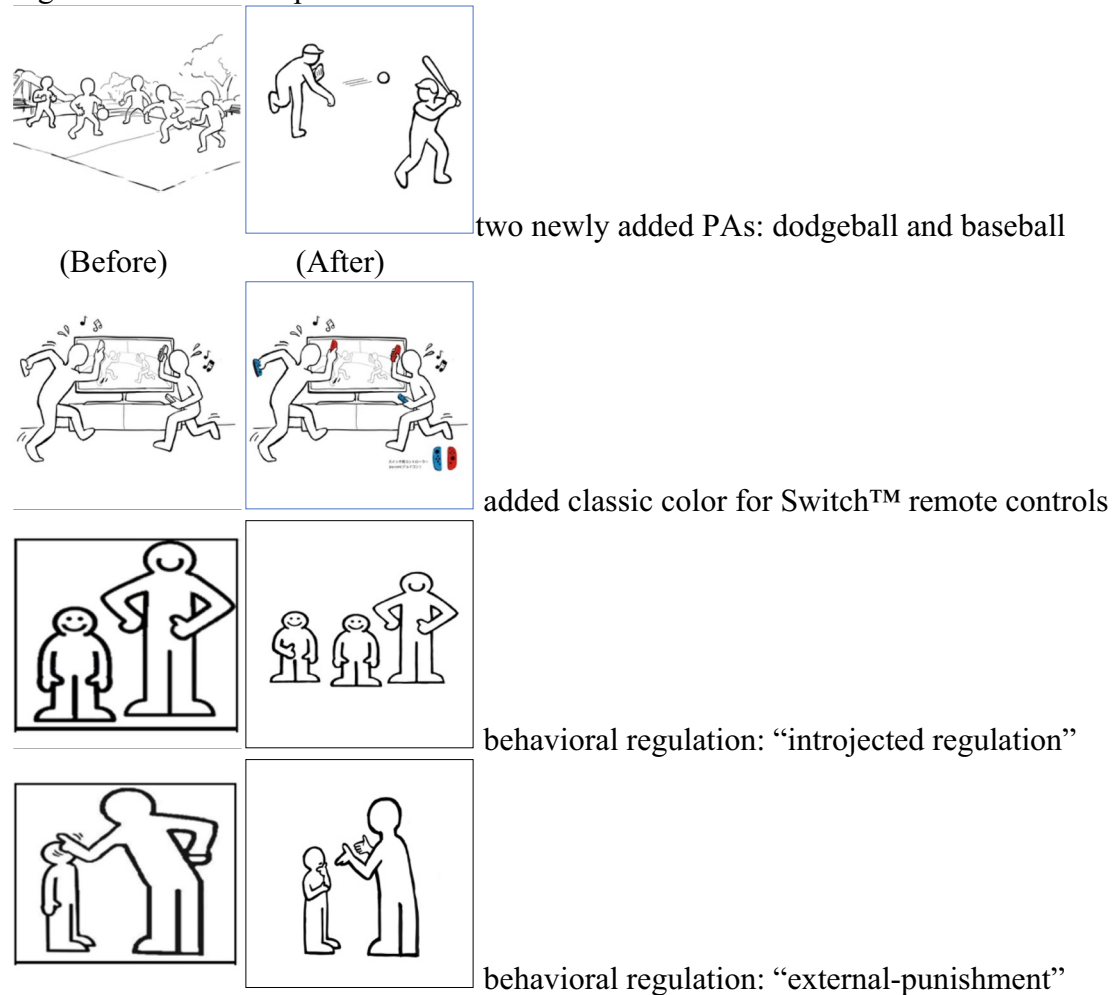


Fig. 3 Revisions to picture resources

companionship, was chosen as a translation to “feel closer” to enhance clarity. For *behavioral regulations*, children sometimes forgot to consider out-of-school contexts and mentioned PAs in school settings. “Outside of school” was added to each item to avoid confusion. The follow-up questions for intrinsic regulation “Why is PA fun?” was hard and abstract to answer sometimes. “What do you enjoy about being physically active outside of school?” was used as an alternative question based on all children’s good responses. In version 0.2, the authors used the statement “I do PA because I want others to think highly of me,” but none of the six children (e.g., child 4, child 6, child 7, child 8, child 9 and child 10) who tested this version chose this regulation type. This led us to conclude that the concept of being thought highly of may be too abstract and indirect for children. The authors then revised it to “I do PA because I want others to think I am a good child” by referring to Ntoumanis (2001)’s tool and considering that “good child”

is a very common term used to praise children in Japanese culture.

Understanding towards activities For *autonomy* activities, all children easily sorted PA cards they had been using for the past 12 months into “You” or “Others” plates. However, they struggled with follow-up questions about task difficulty, such as rule changes, due to the unstructured nature of some out-of-school PA. They found questions about space, equipment, and people easier. The final version now focuses on the top three PAs concerning these aspects. For activities like walking or running that need no equipment, the authors consider only space and people. Future codebook updates will include strategies for coding different activities. For *competence* activities, some children (e.g., child 1, child 9, child 14, and child 16) found it difficult to rate PAs they had never tried before. To improve this, suggestions include having the interviewer perform physical demonstrations (Barnett et al., 2016) of unfamiliar PAs and asking the child

to imagine themselves attempting the activity based on Barnett et al. (2017)'s solutions to a similar question and the definition of competence as "producing desired outcomes" (the need to challenge oneself in PAs never done before). It also shows that a greater variety of competence need satisfaction components are present in this newly suggested activity, such as those represented by the item "I feel I can successfully complete difficult tasks" from the Basic Psychological Need Satisfaction and Need Frustration Scale (Chen et al., 2015). After this, the child can rate their confidence using a 1–5-star scale. For activities related to *relatedness*, some older children (e.g., child 6, child 8, child 9, child 10, and child 19) reported varying feelings towards different PAs. The approach was modified as follows: first, children were asked about their general feelings toward PAs, and then their feelings toward the top three PAs they had participated in were assessed. According to previous studies (Nichols et al., 2019; Obrusnikova & Cavalier, 2011; Stanish et al., 2015), children with ASD might prefer to engage in PAs independently. In our interviews, some children (e.g., child 10, child 14, child 16, child 19, and child 20) listed individual activities as their top three, which made it challenging to assess their feelings about relatedness with specific PAs. Allowing discussions of PAs both generally and specifically provided comprehensive insights. For *behavioral regulations* activities, all children understood that they needed to select one or multiple reasons for engaging in PA and then rank them in order of importance.

Proper responses towards activities For *autonomy* activities, all children had no difficulty in giving responses to "sorting, discussion". For *competence* activities, none of the children gave inappropriate responses rating himself/herself with 0 star or more than 5 stars. For *relatedness* activities, most children reported they were most similar to either child A or child B. Occasionally, their responses (e.g., child 1, child 2, child 4, child 6, child 8, and child 9) were mixed (e.g., sometimes like child A, other times like child B), which was due to varying feelings of relatedness in different PA contexts. This issue was addressed again by separating contexts into general PA and the top three PAs they had participated in. For *behavioral regulation* activities, all children could select and rank cards representing their reasons for engaging in PA. Notably, none of the twelve children tested with versions 0.1, 0.2, and 0.3 chose "amotivation" or "introjected regulation". One child (child 9) mentioned wanting to become stronger and healthier not to boost self-esteem or make a good impression, but to stand up to occasional bullying. Therefore, there is a possibility that children with ASD place greater emphasis on self-esteem in PA (Arnell et al., 2018; Rivera et al., 2020) than was observed in the present study, in which no participants selected "introjected regulation". They may struggle to differentiate between identified and introjected regulation, so this child's choice

could reflect both. This insight is important for codebook development, and further testing with more children could provide additional information. No children chose "amotivation", indicating that all acknowledged the importance of PAs, mainly for extrinsic motivations like losing weight and building strength for their careers. The authors assumed that this focus on extrinsic motivations stems from the group-oriented education Japanese children receive from a young age (Peak, 1989), or from the small sample size in our interviews.

The best recall period The authors discovered that the recall period of "past 12 months" was not mentioned during the interview with two children using version 0.1, which made it difficult for them to recall their memories. As a result, the recall period was added in version 0.2 and was subsequently administered to a total of ten children. For *autonomy and relatedness*, which asked about the top three activities they had been engaged in, most children understood the "past 12 months" timeframe with additional explanation (e.g., from last January to this January or in different seasons). They would clarify when discussing activities outside this period, such as saying, "It was long ago, not even last summer." However, for *competence and behavioral regulation*, it was challenging to limit discussions to the "past 12 months" due to some activities being done years ago or never. MAT-PA aims to understand children's current and recent perceptions of competence. Occasional extensions beyond the recall period are acceptable due to the memory gap between the present and the past. For example, one older child (child 8) mentioned receiving a reward for helping with farm work beyond the 12-month period. The goal of the recall period is to ensure truthful responses. If children are not fabricating stories, a 12-month period is considered appropriate, especially for children with autism who may have additional cognitive challenges (Diehl et al., 2006).

Strengths

Compared with existing motivational assessment tools (Markland & Tobin, 2004; Sebire et al., 2013) for children regarding PA and the one for children with ASD (Pan et al., 2011), MAT-PA has five key strengths.

The First Strength is its Comprehensive and Interactive Developmental Process, as well as the Children's Interviews The development process involved both the authors and external experts with diverse expertise. In this study, the authors included children with ASD through purposive sampling, ensuring that content validity was assessed from multidisciplinary perspectives rather than narrow ones (Terwee et al., 2018). Content validity was assessed by interviewing children with ASD, which helps raise awareness of PA participation for children themselves. It enables children

to voice their own perceptions, helps children starting to reflect on their own experiences, and to enhance children's self-awareness regarding PA participation and health. For example, one child (child 2) mentioned that he would like to resume his abandoned workout plan after the interview. Another child (child 6) was reminded of the importance of going out instead of staying at home all the time. Similar to findings from other studies focusing on first-person experiences (Harrington et al., 2014; Tesfaye et al., 2023), our findings indicate that willingness and patience in listening to children can be fundamental. This robust process indicates that future measurement studies could consider including children themselves, though challenging yet manageable, rather than focusing solely on the stakeholders (e.g., policy makers, schools, and parents).

The Second Strength is that the Presence of Stakeholders Amongst the Research Process, which Created a Mutual Learning Opportunity

It is common for stakeholders to speak on behalf of children; for example, focus groups are often organized to better support children among healthcare professionals, teachers and parents (Bolourian et al., 2022; Tawankanjanachot et al., 2024). However, it barely creates a platform to ensure the presence of all stakeholders and children in the same setting. A recent study includes young adults but not children (Lee et al., 2022). MAT-PA interviews with children allow parents, PE teachers, or homeroom teachers to be present if they are willing to, and some have noted that listening to the interviews provides valuable insights into children's PA behaviors. For example, one child (child 14) mentioned that while his mother signed him up for swimming courses, he would have preferred more options if given the chance to choose for himself. His mother did not realize his true thoughts until MAT-PA provided a platform for him to express them. Another child (child 16)'s PE teacher, who was present during the interview, learned about the child's extracurricular activities through the talk. The teacher also showed interest in the content of MAT-PA and expressed a desire to incorporate MAT-PA elements (such as satisfaction needs) into future lessons. The third party (the first author as the interviewer and MAT-PA as the platform) serves as a turning point or coordinator in addressing inadequate stakeholder-child communication and understanding.

The Third Strength is its Simplicity and Potential Benefits for a Diverse Target Population Across a Broader Age Range

MAT-PA is the first pictorial tool featuring interactive, game-like activities that assess children's motivational perceptions of PA. It has been found to be feasible for one-on-one administration by an interviewer in a quiet, familiar

location for the child, using relatively low-cost resources. Some children (e.g., child 4, child 20) expressed that they felt like they were participating in a game, rather than in a research study with the interviewer. Future studies could choose a setting familiar to the child and incorporate more game-like resources (e.g., Pokémon™ Pikachu cards were used) and activities into the research. In addition, in most studies involving children with autism (Kangarani-Farahani et al., 2024; Kaur et al., 2024), the required minimum mental age/IQ is explicitly stated in the eligibility criteria. MAT-PA allows the children who do not meet the assumed minimum age to be participants, if the child is regarded as having no issues with expressive and receptive language in daily life from the perspective of the parents. Although it was assumed that a child with receptive or expressive skills comparable to those of a 5- to 6-year-old should be able to use MAT-PA, it was found that children with receptive skills at a 3-year-old level can also participate. Underestimation should be avoided in the future. Moreover, while MAT-PA is designed for children with ASD, it may also provide insights into the motivational dynamics of neurodiverse children. MAT-PA could potentially serve as a tool to deeply explore the motivational perceptions of typically developing children.

The Fourth Strength is its Consideration of Both General and Specific Aspects of Out-of-School PA, Providing an In-Depth Exploration of Motivation Within These Complex Contexts

It has been demonstrated that children and adults with disabilities (including autism) are less active on non-school/workdays (Helsel et al., 2024). Thus, it is important to examine the out-of-school contexts where future studies and policymakers can place more emphasis on PA promotion among these populations. In MAT-PA, in addition to general out-of-PA activities, interviews with children about their top three PA activities were included, along with discussions on autonomy, competence, and relatedness with both adults and peers across a wide range of PA types. This equipped MAT-PA with a more comprehensive perspective and ensured that important details about the most frequently engaged activities were not neglected. As a result, MAT-PA is better able to address the diverse needs and personal experiences of children with ASD.

The Fifth Strength is its Versatility for Research and Practice

Like other assessment tools, MAT-PA can serve as a tool for motivation assessment in interventional studies, focusing on pre- and post-assessments, changes, and informing improvements for children with ASD. Additionally, MAT-PA can be used as a guideline and checklist to help researchers, community sports coaches, after-school facility

coordinators, and paediatric physical and occupational therapists modify their interaction styles and practices with children in out-of-school physical activities. To ensure MAT-PA's scalability and impact, transforming it into an app could help authorities automatically record children's responses to the interview questions and maintain better records. This would make it easier for researchers and practitioners to track historical data and compare it with updated information, rather than getting lost in verbatim transcription. Pictorial resources could also be better organized in this way.

Limitations

This study is not without limitations. *One limitation* is the difficulty arising when children were asked to recall their competence in out-of-school contexts, especially if they had only experienced PAs in school settings. In such cases, the interviewer would ask children to imagine their competence in out-of-school contexts and then rate it. MAT-PA discussions focus on self-reported PA data for children with ASD, who may have memory and cognitive challenges (Brien & Hutchins, 2024). Recall bias is a limitation that cannot be avoided, and while children may recall meaningful activities better, there's still a risk of inaccurate or incomplete reporting, especially for less frequent or salient activities. *A second limitation* is that the criterion "no other disabilities that affect daily life" may exclude many children with ASD. While those with comorbidities are often more sedentary (Sung et al., 2023), the goal is to develop a pictorial assessment that eventually accommodates these children. The current focus is on children without other disabilities to build a solid foundation. *A third limitation* is that MAT-PA has not yet undergone rigorous back-translation by an external translator, but this will be addressed as MAT-PA evolves into a standardized tool. *A fourth limitation* is the small sample size for determining age equivalents for daily verbal communication with the VABS-2. A larger sample would improve precision, but due to the diversity among children with autism and complexity of skills needed for the MAT-PA, exceptions are unavoidable. In our sample of twenty, one child (child 20) did not meet the expected receptive skills for 3-year-olds or expressive skills for 6-year-olds but fully engaged in the interview. Conversely, some children (e.g., child 4, child 14, and child 16) who met the age criteria could not complete the interview. Thus, the authors encourage attempting the assessment as long as the child's age equivalents are relatively close to the minimum age requirements. *A fifth limitation* is the administration time, which takes 45 min to 1 h. Although this is longer than traditional questionnaires, it is worthwhile given the depth and richness of the data provided by children. After-school services in

Japan often include physical therapy (PT) or occupational therapy (OT) sessions conducted by therapists. In addition, children may attend PT or OT sessions in medical settings. *A final limitation* of this study is that it did not explicitly address regular or frequent therapy-based PAs in MAT-PA, which contribute to overall out-of-school PA levels. Further development could include a discussion of therapy-based PAs.

Conclusion

The MAT-PA is the first comprehensive and innovative tool designed to assess Basic Psychological Needs Satisfaction (BPNS) and motivation (behavioral regulation) in out-of-school PA among children with ASD. The MAT-PA addresses gaps in the existing literature by incorporating a participatory, pictorial and interactive approach that is inclusive for children with diverse developmental abilities. The MAT-PA has demonstrated content validity, through its iterative development process, which involved children with ASD, external experts and multidisciplinary perspectives (An et al., 2025 under review).

By addressing the motivational dynamics within out-of-school PA contexts, MAT-PA provides a potential significant resource for researchers, educators, and policymakers aiming to promote PA and health equity among children with ASD. Future work should focus on refining reliability of the tool for consideration in trial integration, exploring its applicability across diverse cultural and developmental contexts, and leveraging technology to enhance its scalability and impact.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10803-025-06824-w>.

Acknowledgements The authors would like to thank the parents and children, as well as the external experts, for participating in this study. The authors also thank the school principals and vice principals, Naoko Hino (after-school day care: Little Oranges), Ayako Miyanohara, Hikaru Hashiguchi, Riko Nishida (after-school day care offered by Good Job Groups through Sakura-bio Co., Ltd.), Kaeko Miyauchi (Autism Society of Kyoto), Noriko Nakagawa (ONLY ONE—Parents Association for ASD in Kyoto), Terumasa Kawano (after-school day care: Social Welfare Corporation Tsuitachi), Moto Ikezoe (after-school day care: Fukushi Hiroba), Kazuki Doi (after-school day care/rehabilitation studio for developmental disorders: Happy Ring Service Group), Hisatsugu Sasai (after-school day care: TOMOMO) for their help with the recruitment of parents and children. The authors would also like to thank Dr. Xitong Liao for designing the pictorial resources. Additionally, the authors would like to thank Dr. Hiroyuki Inadomi and Mrs. Mariko Sasai for their support. The first author would like to give special thanks to her parents, Dr. Anqiang Xiang and Mrs. Chengzhi Xie, for their unwavering support. For the purpose of open access, the authors have applied a Creative Commons Attribution (CC BY) licence to any Author Accepted Manuscript version arising from this submission.

Authors Contribution MA: Conceptualisation, Methodology, Validation, Formal analysis, Data curation, Investigation, Resources, Writing—original draft, Writing—review & editing. KFD: Conceptualisation, Methodology, Writing—review & editing. JR: Conceptualisation, Methodology, Writing—review & editing. SJR: Conceptualisation, Methodology, Writing—review & editing. FB: Conceptualisation, Methodology, Writing—review & editing. ZK: Conceptualisation, Methodology, Writing—review & editing. LF: Conceptualisation, Methodology, Writing—review & editing. TS: Validation, Investigation, Resources. RI: Validation, Resources. MI: Validation. MK: Validation. YK: Methodology. AT: Methodology. TK: Conceptualisation, Methodology, Validation, Resources, Writing—review & editing, Project administration, Supervision.

Funding No funding was received to assist with the preparation of this manuscript.

Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

Ethical Approval All procedures undertaken in the current study were in accordance with ethical standards and received approval from Ethics Committee, Graduate School and Faculty of Medicine, Kyoto University (R4063-2).

Informed Consent and Informed Assent Informed Consent was obtained from all parents and all children who are or older than 16 years old included in the study. Informed Assent was obtained from children aged 7–15 years old included in the study.

References

- Abadi, R. H. M., Zheng, Y., Wharton, T., Dell, C., Vatanparast, H., Johnston, J., & Kontulainen, S. (2023). Children with autism spectrum disorder spent 30 min less daily time in moderate-to-vigorous physical activity than typically developing peers: A meta-analysis of cross-sectional data. *Review Journal of Autism and Developmental Disorders*, 10(1), 144–157. <https://doi.org/10.1007/s40489-021-00262-x>
- Accardo, A. L., Pontes, N. M. H., & Pontes, M. C. F. (2024). Greater physical activity is associated with lower rates of anxiety and depression among autistic and ADHD youth: National survey of children's health 2016–2020. *Journal of Autism and Developmental Disorders*, 54(11), 4006–4018. <https://doi.org/10.1007/s10803-023-06117-0>
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (Vol. 5). American Psychiatric Association
- An, M., Bardid, F., Davies, K. F., Fowweather, L., Knowles, Z., Roberts, S. J., Rudd, J., Sasai, T., Ito, R., Inoue, M., Komaki, M., Kusano, Y., Tabata, A., Kato, T. (2025). Development and initial content validation of the Motivation Assessment Tool for Physical Activity (MAT-PA) among children with autism spectrum disorder. *Journal of Autism and Developmental Disorders* (under review).
- Arnell, S., Jerlinder, K., & Lundqvist, L. O. (2018). Perceptions of physical activity participation among adolescents with autism spectrum disorders: A conceptual model of conditional participation. *Journal of Autism and Developmental Disorders*, 48(5), 1792–1802. <https://doi.org/10.1007/s10803-017-3436-2>
- Barnett, L. M., Vazou, S., Abbott, G., Bowe, S. J., Robinson, L. E., Ridgers, N. D., & Salmon, J. (2016). Construct validity of the pictorial scale of perceived movement skill competence. *Psychology of Sport and Exercise*, 22, 294–302. <https://doi.org/10.1016/j.psychsport.2015.09.002>
- Barnett, L. M., Ridgers, N. D., Hesketh, K., & Salmon, J. (2017). Setting them up for lifetime activity: Play competence perceptions and physical activity in young children. *Journal of Science and Medicine in Sport*, 20(9), 856–860. <https://doi.org/10.1016/j.jsams.2017.03.003>
- Block, M., Whaley, D., Johnson, M., & Judge, J. (2022). Utilizing self-determination theory to promote physical activity in individuals with autism spectrum disorder. *Palaestra*, 36(3), 50–55.
- Bolourian, Y., Losh, A., Hamsho, N., Eisenhower, A., & Blacher, J. (2022). General education teachers' perceptions of autism, inclusive practices, and relationship building strategies. *Journal of Autism and Developmental Disorders*, 52(9), 3977–3990. <https://doi.org/10.1007/s10803-021-05266-4>
- Brien, A. R., & Hutchins, T. L. (2024). The everyday autobiographical memory of autistic children: A qualitative analysis of parent interviews. *Topics in Language Disorders*, 44(4), 285–303. <https://doi.org/10.1097/tld.0000000000000349>
- Brooke, H. L., Corder, K., Atkin, A. J., & van Sluijs, E. M. F. (2014). A systematic literature review with meta-analyses of within- and between-day differences in objectively measured physical activity in school-aged children. *Sports Medicine*, 44(10), 1427–1438. <https://doi.org/10.1007/s40279-014-0215-5>
- Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van der Kaap-Deeder, J., Duriez, B., Lens, W., Matos, L., Mouratidis, A., Ryan, R. M., Sheldon, K. M., Soenens, B., Van Petegem, S., & Verstuyf, J. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion*, 39(2), 216–236. <https://doi.org/10.1007/s11031-014-9450-1>
- Constantino, J. N., Gruber, C. P., & Kamio, Y. (2017). *Social responsiveness scale (SRS-2) Manual*. [Japanese Social Responsiveness Scale Second Edition]. Nihon Bunka Kagakusha.
- Davies, K., Watson, P. M., Rudd, J. R., Roberts, S., Bardid, F., Knowles, Z., & Fowweather, L. (2021). Development and validity of the Motivation Assessment Tool for Physical Education (MAT-PE) among young children. *Psychology of Sport & Exercise*. <https://doi.org/10.1016/j.psychsport.2021.101915>
- de Bruijn, A. G. M., de Greeff, J. W., Tamlali, T. Y., Oosterlaan, J., Smith, J., & Hartman, E. (2023). Objectively measured physical activity during primary school physical education predicts intrinsic motivation independently of academic achievement level. *British Journal of Educational Psychology*, 93(S1), 90–112. <https://doi.org/10.1111/bjep.12527>
- Deci, E. L., & Ryan, R. M. (1985a). Conceptualizations of intrinsic motivation and self-determination. In *Intrinsic motivation and self-determination in human behavior*. Springer. <https://doi.org/10.1007/978-1-4899-2271-7>
- Deci, E. L., & Ryan, R. M. (1985b). Toward an organismic integration theory. In *Intrinsic motivation and self-determination in human behavior*. Springer. https://doi.org/10.1007/978-1-4899-2271-7_5
- Deci, E. L., & Ryan, R. M. (2000). The “What” and “Why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01
- Diehl, J. J., Bennetto, L., & Young, E. C. (2006). Story recall and narrative coherence of high-functioning children with autism spectrum disorders. *Journal of Abnormal Child Psychology*, 34(1), 83–98. <https://doi.org/10.1007/s10802-005-9003-x>
- Dunn, L. M., & Dunn, L. M. (1981). *Peabody Picture Vocabulary Test-Revised (PPVT-R)*. American Guidance Services.

- Eime, R. M., Harvey, J. T., Sawyer, N. A., Craike, M. J., Symons, C. M., Polman, R. C. J., & Payne, W. R. (2013). Understanding the contexts of adolescent female participation in sport and physical activity. *Research Quarterly for Exercise and Sport*, 84(2), 157–166. <https://doi.org/10.1080/02701367.2013.784846>
- Eime, R. M., Harvey, J. T., Sawyer, N. A., Craike, M. J., Symons, C. M., & Payne, W. R. (2016). Changes in sport and physical activity participation for adolescent females: A longitudinal study. *BMC Public Health*, 16(1), 533. <https://doi.org/10.1186/s12889-016-3203-x>
- Fraguela-Vale, R., Varela-Garrote, L., Carretero-García, M., & Peralbo-Rubio, E. M. (2020). Basic psychological needs, physical self-concept, and physical activity among adolescents: Autonomy in focus. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2020.00491>
- Fuki, N. (2002). The Role of Cultural Influences in Japanese Communication: A Literature Review on Social and Situational Factors and Japanese Indirectness.
- Harrington, C., Foster, M., Rodger, S., & Ashburner, J. (2014). Engaging young people with autism spectrum disorder in research interviews. *British Journal of Learning Disabilities*, 42(2), 153–161. <https://doi.org/10.1111/bld.12037>
- Healy, S., Nacario, A., Braithwaite, R. E., & Hopper, C. (2018). The effect of physical activity interventions on youth with autism spectrum disorder: A meta-analysis. *Autism Research*, 11(6), 818–833. <https://doi.org/10.1002/aur.1955>
- Helsel, B. C., Bodde, A. E., Ptomey, L. T., Sherman, J. R., Rice, A., Donnelly, J. E., & Washburn, R. A. (2024). Physical activity patterns in adolescents and adults with intellectual and developmental disabilities. *Exercise, Sport, and Movement*, 2(3), e00024. <https://doi.org/10.1249/esm.0000000000000024>
- Howells, K., Sivaratnam, C., May, T., Lindor, E., McGillivray, J., & Rinehart, N. (2019). Efficacy of group-based organised physical activity participation for social outcomes in children with autism spectrum disorder: A systematic review and meta-analysis. *Journal of Autism and Developmental Disorders*, 49(8), 3290–3308. <https://doi.org/10.1007/s10803-019-04050-9>
- Jiang, J., Wang, G., Gu, Q., Wang, X., & Liu, J. (2024). Quantifying the efficacy of physical activity on motor skills and stereotypes in children with autism spectrum disorder: A meta-analysis of randomized controlled trials from the last decade. *Research in Autism Spectrum Disorders*, 114, 102395. <https://doi.org/10.1016/j.rasd.2024.102395>
- Kahathuduwa, C. N., West, B. D., Blume, J., Dharavath, N., Moustaid-Moussa, N., & Mastergeorge, A. (2019). The risk of overweight and obesity in children with autism spectrum disorders: A systematic review and meta-analysis. *Obesity Reviews*, 20(12), 1679–1667. <https://doi.org/10.1111/obr.12933>
- Kangarani-Farahani, M., Malik, M. A., & Zwicker, J. G. (2024). Motor impairments in children with autism spectrum disorder: A systematic review and meta-analysis. *Journal of Autism and Developmental Disorders*, 54(5), 1977–1997. <https://doi.org/10.1007/s10803-023-05948-1>
- Kaur, K., Pany, S., Mohanty, S. P., Sahoo, P. K., & Rana, S. (2024). Efficacy of cognitive behavioral intervention in improving executive function of children with high functioning autism spectrum disorder: A meta-analysis. *International Journal of Special Education*, 39(1), 11–20. <https://doi.org/10.52291/ijse.2024.39.2>
- Kelly, V. E. (2001). Peer culture and interaction: How Japanese children express their internalization of the cultural norms of group life (shudan seikatsu). *Japanese frames of mind cultural perspectives on human development* (pp. 170–201). Cambridge University Press.
- Klein, W., Graesch, A. P., & Izquierdo, C. (2009). Children and chores: A mixed-methods study of children's household work in Los Angeles families. *Anthropology of Work Review*, 30(3), 98–109. <https://doi.org/10.1111/j.1548-1417.2009.01030.x>
- Lee, G. K., Curtiss, S. L., Kuo, H. J., Chun, J., Lee, H., & Nimako, D. D. (2022). The role of acceptance in the transition to adulthood: A multi-informant comparison of practitioners, families, and youth with autism. *Journal of Autism and Developmental Disorders*, 52(4), 1444–1457. <https://doi.org/10.1007/s10803-021-05037-1>
- Li, L., Møller Christensen, B., Falkmer, M., Zhao, Y., & Huus, K. (2023). Content validity of the instrument 'Picture My Participation' for measuring participation of children with and without autism spectrum disorder in mainland China. *Scandinavian Journal of Occupational Therapy*, 30(8), 1237–1247. <https://doi.org/10.1080/11038128.2023.2220911>
- Liang, X., Li, R., Wong, S. H. S., Sum, R. K. W., & Sit, C. H. P. (2020). Accelerometer-measured physical activity levels in children and adolescents with autism spectrum disorder: A systematic review. *Preventive Medicine Reports*, 19, 101147. <https://doi.org/10.1016/j.pmedr.2020.101147>
- Markland, D., & Tobin, V. (2004). A modification to the behavioural regulation in exercise questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology*, 26(2), 191–196. <https://doi.org/10.1123/jsep.26.2.191>
- Ministry of Education, Culture, Sports, Science and Technology Ministry of Health, Labour and Welfare Ministry of Economy, Trade and Industry (2021). 人を対象とする生命科学・医学系研究に関する倫理指針ガイダンス (Ethical Guidelines for Medical and Biological Research Involving Human Subjects). https://www.mext.go.jp/content/20240408-ope_dev01-000034640_1.pdf
- Mokkink, L. B., Terwee, C. B., Patrick, D. L., Alonso, J., Stratford, P. W., Knol, D. L., Bouter, L. M., & de Vet, H. C. (2010). The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. *Journal of Clinical Epidemiology*, 63(7), 737–745. <https://doi.org/10.1016/j.jclinepi.2010.02.006>
- Nagase, N. (2024). Much to be done in Japan's family and gender equality policies. *Asia Pacific Business Review*, 30(3), 528–542. <https://doi.org/10.1080/13602381.2024.2320546>
- Nichols, C., Block, M. E., Bishop, J. C., & McIntire, B. (2019). Physical activity in young adults with autism spectrum disorder: Parental perceptions of barriers and facilitators. *Autism*, 23(6), 1398–1407. <https://doi.org/10.1177/1362363118810221>
- Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. *British Journal of Educational Psychology*, 71(2), 225–242. <https://doi.org/10.1348/000709901158497>
- Obrusnikova, I., & Cavalier, A. R. (2011). Perceived barriers and facilitators of participation in after-school physical activity by children with autism spectrum disorders. *Journal of Developmental and Physical Disabilities*, 23(3), 195–211. <https://doi.org/10.1007/s10882-010-9215-z>
- Okkenhaug, I., Jensen, M. R., & Solhaug, S. (2024). Barriers and facilitators for physical activity among children and youth with autism—a scoping review. *Journal of Physical Activity and Health*, 21(10), 965–979. <https://doi.org/10.1123/jpah.2024-0075>
- Pan, C. Y., Tsai, C. L., Chu, C. H., & Hsieh, K. W. (2011). Physical activity and self-determined motivation of adolescents with and without autism spectrum disorders in inclusive physical education. *Research in Autism Spectrum Disorders*, 5(2), 733–741. <https://doi.org/10.1016/j.rasd.2010.08.007>
- Peak, L. (1989). Learning to become part of the group: The Japanese child's transition to preschool life. *The Journal of Japanese Studies*, 15(1), 93–123. <https://doi.org/10.2307/132409>
- Piggin, J. (2020). What is physical activity? A holistic definition for teachers, researchers and policy makers [Conceptual Analysis].

- Frontiers in Sports and Active Living*. <https://doi.org/10.3389/fspor.2020.00072>
- Rivera, P., Renziehausen, J., & Garcia, J. M. (2020). Effects of an 8-Week judo program on behaviors in children with autism spectrum disorder: A mixed-methods approach. *Child Psychiatry & Human Development*, 51(5), 734–741. <https://doi.org/10.1007/s10578-020-00994-7>
- Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Press. <https://doi.org/10.1521/978.14625/28806>
- Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, 61, 101860. <https://doi.org/10.1016/j.cedpsych.2020.101860>
- Sarmiento, M. I., Hwang, J., & Midgette, A. J. (2024). “The children don’t do enough”: Including children in fairness perceptions of housework. *Journal of Marriage and Family*, 86(2), 433–454. <https://doi.org/10.1111/jomf.12966>
- Sasakawa Sports Foundation. (2021). *The 2021 SSF National Sports-Life Survey of Children and Young People Executive Summary*. https://www.ssf.or.jp/en/files/sld2021_eng_s.pdf
- Sasakawa Sports Foundation. (2023). *The 2023 SSF National Sports-Life Survey of Children and Young People Executive summary*. https://www.ssf.or.jp/en/files/2023_SSF_National_Sports-Life_Survey.pdf
- Sebire, S. J., Jago, R., Fox, K. R., Edwards, M. J., & Thompson, J. L. (2013). Testing a self-determination theory model of children’s physical activity motivation: A cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, 10(1), 111. <https://doi.org/10.1186/1479-5868-10-111>
- Sowa, M., & Meulenbroek, R. (2012). Effects of physical exercise on autism spectrum disorders: A meta-analysis. *Research in Autism Spectrum Disorders*, 6(1), 46–57. <https://doi.org/10.1016/j.rasd.2011.09.001>
- Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2014). *Japanese version of Vineland adaptive behavior scales* (2nd ed.). Nihon Bunka Kagakusha.
- Stanish, H., Curtin, C., Must, A., Phillips, S., Maslin, M., & Bandini, L. (2015). Enjoyment, barriers, and beliefs about physical activity in adolescents with and without autism spectrum disorder. *Adapted Physical Activity Quarterly*, 32(4), 302–317. <https://doi.org/10.1123/apaq.2015-0038>
- Stanish, H. I., Curtin, C., Must, A., Phillips, S., Maslin, M., & Bandini, L. G. (2017). Physical activity levels, frequency, and type among adolescents with and without autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 47(3), 785–794. <https://doi.org/10.1007/s10803-016-3001-4>
- Sung, M. C., Tsai, C. L., Chen, F. C., Chen, C. C., Chu, C. H., & Pan, C. Y. (2023). Physical activity, sedentary pursuits, and their determinants in children with autism spectrum disorders. *Journal of Developmental and Physical Disabilities*, 35(4), 683–696. <https://doi.org/10.1007/s10882-022-09874-5>
- Tawankanjanchot, N., Truesdale, M., Orachon, P., & Kidd, L. (2024). Social skills interventions for Thai adolescents with Autism Spectrum Disorder (ASD): A qualitative study of the perceptions and experiences of Thai adolescents, their caregivers and healthcare professionals. *International Journal of Mental Health Systems*, 18(1), 1. <https://doi.org/10.1186/s13033-023-00617-3>
- Terwee, C. B., Prinsen, C. A. C., Chiarotto, A., Westerman, M. J., Patrick, D. L., Alonso, J., Bouter, L. M., de Vet, H. C. W., & Mokkink, L. B. (2018). COSMIN methodology for evaluating the content validity of patient-reported outcome measures: A Delphi study. *Quality of Life Research*, 27(5), 1159–1170. <https://doi.org/10.1007/s11136-018-1829-0>
- Tesfaye, R., Courchesne, V., Mirenda, P., Mitchell, W., Nicholas, D., Singh, I., Zwaigenbaum, L., & Elsabbagh, M. (2023). Autism voices: Perspectives of the needs, challenges, and hopes for the future of autistic youth. *Autism*, 27(4), 1142–1156. <https://doi.org/10.1177/13623613221132108>
- To, Q. G., Stanton, R., Schoeppe, S., Doering, T., & Vandelanotte, C. (2022). Differences in physical activity between weekdays and weekend days among U.S. children and adults: Cross-sectional analysis of NHANES 2011–2014 data. *Preventive Medicine Reports*, 28, 101892. <https://doi.org/10.1016/j.pmedr.2022.101892>
- Ueno, K., Nagoshi, N., & Konuki, S. (2008). *Picture Vocabulary Test - Revised*. Nihon Bunka Kagakusha.
- Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 29, pp. 271–360). Academic Press. [https://doi.org/10.1016/S0065-2601\(08\)60019-2](https://doi.org/10.1016/S0065-2601(08)60019-2)
- World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. World Health Organization. <https://apps.who.int/iris/handle/10665/336656>
- Wong, M. L., Girdler, S., Afsharnejad, B., Ntoumanis, N., Milbourn, B., Keble, P., Morris, S., & Black, M. H. (2024). Motivation to participate in structured physical activity for autistic youth: A systematic scoping review. *Autism*, 28(10), 2430–2444. <https://doi.org/10.1177/13623613241240603>
- Yamaoka, Y., Ochi, M., Fukui, M., Isumi, A., Doi, S., Fujiwara, T., & Nawa, N. (2024). Home visitors’ needs and perceptions of the benefits of a home visiting program for childcare support in Japan: A qualitative study of home visitors. *Child Abuse & Neglect*, 153, 106853. <https://doi.org/10.1016/j.chiabu.2024.106853>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.

A scoping review of adapted physical activity interventions for children and youth with disabilities using international classification of functioning, disability and health: children and youth version as a reference

Mi An¹ , Reia Tanaka¹, Naho Hirota¹, Takehiro Sasai¹, Hideki Takahashi¹ , Yuuya Ogawa¹, Shizuko Horai¹, Mayumi Inoue¹, Randeep Rakwal²  and Toshihiro Kato^{1,3} 

¹Department of Human Health Sciences, Graduate School of Medicine, Kyoto University, Kyoto, Japan; ;

²Institute of Health and Sport Sciences, University of Tsukuba, Ibaraki, Japan; ³Faculty of Rehabilitation, Kansai Medical University, Osaka, Japan

Purpose: Adapted physical activity (APA) provides children and youth with disabilities more opportunities to be physically active. Nevertheless, it is not well known how APA implementation in different services has benefited them. This study reviews the existing literature on APA interventions to identify characteristics and program descriptions, and to primarily synthesize information relating to the goals, for children and youth with disabilities.

Methods: A literature search was performed using (1) electronic databases Scopus and EBSCO ALL and (2) manual and individual scrutinization of the four major APA journals. The characteristics and program were summarized narratively, and outcome items were extracted using the established International Classification of Functioning, Disability and Health: Children and Youth version (ICF-CY) linking rules.

Results: Thirty-five APA intervention studies published between 1987 and 2020 (with the majority in North America, since 2000) were included. Children with autism are the largest target group. Rich and diverse programs implemented were proved to be effective. Among the 184 outcome items coded within the categories of ICF-CY, 48% focused on Body Functions while 52% focused on Activities and Participation.

Conclusions: This scoping review provides APA professionals and non-professionals (e.g. guardians) a broader and systematic overview on existing APA interventions for children and youth with disabilities.

Keywords: intervention characteristics; program descriptions; goals; adapted physical activity; children and youth with disabilities; scoping review; ICF-CY

Background

Physical activity in the children and youth with disabilities

Physical activity (hereafter abbreviated as PA) is associated with improved health, psychological benefits, and social development among children and youth (with or without disabilities) (Murphy *et al.* 2008, Poitras *et al.* 2016). According to the Global Matrix 2.0 and 3.0 (Aubert *et al.* 2018, Tremblay *et al.* 2016),

there is ‘new evidence showing that the situation regarding the PA of children and youth is a concern worldwide’. By looking at the WHO guidelines and recommendations (World Health Organization 2010), which provide details for children and youth aged 5–17 years (with and without disabilities) on how much PA is indispensable for good health, no difference was found among children and youth with and without disabilities. However, compared to their typically developing peers, children and youth with disabilities are at a higher risk of obesity (Collins and Staples 2017, Hinckson *et al.* 2013), and do not achieve the

Correspondence to: Mi An, Department of Human Health Sciences, Graduate School of Medicine, Kyoto University, Kyoto, Japan. Email: nilo23452345@gmail.com

recommended level of daily PA (Lobenius-Palmér *et al.* 2018). It is already alarming that children and youth worldwide are not engaging in PA as recommended. Furthermore, it is especially hard to notice that the situation is more severe for children and youth with disabilities. In fact, children and youth with disabilities experience significant restrictions in participating in PA (McGarty and Melville 2018, Tonkin *et al.* 2014), mainly related to individual, familial, and wider environmental concerns and factors (King *et al.* 2003). Due to the complexity of barriers (ranging from individual child's level of functioning to the person–environment contextual factors) (McGarty and Melville 2018, Shields *et al.* 2012) impeding overall PA participation, interventions seeking to implement PA for children and youth with disabilities can be especially difficult.

Adapted physical activity has the interventional potential for children and youth with disabilities as a cross-disciplinary body of knowledge

In recent decades, research has revealed the potential of interventions based on adapted physical activity (hereafter abbreviated as APA) dealing with individual difference, and the children and youth with disabilities are no exceptions (Steadward *et al.* 2003). According to the International Federation of APA, '*APA is defined as a cross-disciplinary body of knowledge directed toward the identification and solution of individual differences in PA. It is a service delivery profession and an academic field of study that supports an attitude of acceptance of individual differences, advocates access to active lifestyles and sport, and promotes innovation and cooperative service delivery programs and empowerment systems. APA includes, but is not limited to, physical education, sport, recreation, dance and creative arts, nutrition, medicine, and rehabilitation*' (IFAPA 2014). It has also been widely acknowledged that intervention and services for children and youth with disabilities operate on an interdisciplinary basis (Björck-Åkesson *et al.* 2010). APA professionals from various disciplines are likely to be able to provide children and youth with disabilities a diversity of experiences in PA participation, whereas the definition of APA and the meaningfulness of implementing APA across individual differences lack specificity. It is too conceptual to understand or capture a clear picture as to how APA has been implemented among children and youth with disabilities to support their needs. In type usage, 'adapt' means 'to adjust' or 'to fit', and the meaning of adapt in APA's working definition is consistent with this understanding by including modifications to meet the needs of children and youth with disabilities (Winnick 2010). What can be grasped from the APA definition is that APA can be a service delivery that uses modifications of PAs to cater to the children and youth with

disabilities needs and support an attitude of acceptance of individual differences and to advocate access to active lifestyles and sport. Because of the wide range of disciplines, goals and target groups involved in APA, a systematic overview of APA interventions implemented for children and youth with disabilities is not yet available. To the best of our knowledge, existing reviews attempting to clarify the PA interventions for children and youth with disabilities either narrow the focus to a single type of disability (Howells *et al.* 2019, Kilgour *et al.* 2022) or focuses on a particular setting; for example, in an out-of-school context (Arbour-Nicitopoulos *et al.* 2018, Orr *et al.* 2021), or in a school-based context (Wilhelmsen and Sørensen 2017). Only one review discussed a similar topic excluding therapeutic interventions, but this is a review of a review (Lai *et al.* 2020).

A common framework used to synthesize information relating to the multidisciplinary APA interventions' goals

To better understand how APA has been implemented in different services across countries in relation to children and youth with different kinds of disabilities, especially in terms of the intervention goals, there is a requirement for a common language between professionals and a shared framework for intervention goals (outcome items). The International Classification of Functioning, Disability and Health for Children and Youth (hereafter abbreviated as ICF-CY), derived from the International Classification of Functioning, Disability and Health (ICF) (World Health Organization 2001), may serve as the common framework that can be applied across disciplines as well as national boundaries to: (1) facilitate the documentation of health and disability in children and youth, and, (2) advance services and research on behalf of children and youth (World Health Organization 2007). It is a biopsychosocial model by facilitating to understand human functioning with three interrelated components; namely, body functions and body structures and activities and participation. This model also includes contextual (personal and environmental) factors that interact with the three components of human functioning. Within the ICF-CY, children's functioning and disability are viewed as being a dynamic interaction between health conditions and contextual factors. APA is a production of the evolving concepts from 'corrective therapy' to 'adapted physical education' and then 'adapted physical activity' (shifting the emphasis from correcting personal functioning impairments to focusing on solving problems on overall interaction of person–environment context) (Steadward *et al.* 2003). The fundamental concept of APA accords with how the ICF-CY model recognizes children's functioning and disability. In addition, the ICF-CY model has been useful for

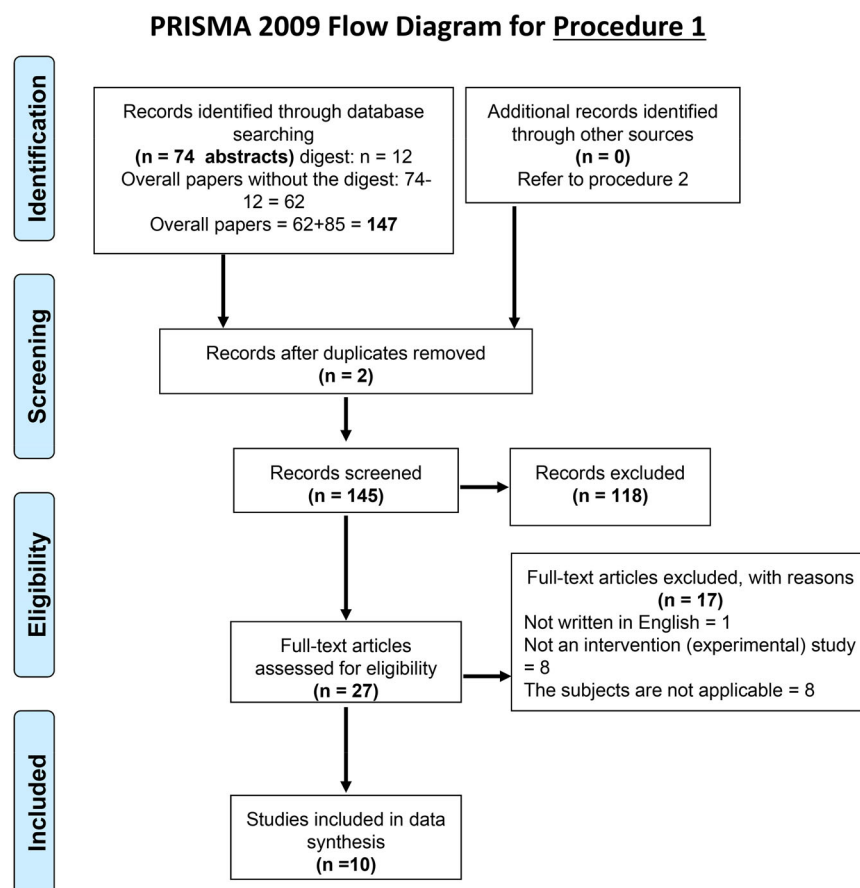


Figure 1. A summary of the screening process for procedure 1.

identifying potential points of interventions for children, including those with disabilities (Hwang *et al.* 2014, Tantilipikorn *et al.* 2012, World Health Organization 2007, Yildiz Kabak *et al.* 2021). Practically, the ICF-CY model can help define areas of intervention after understanding the child's need (McDougall and Wright 2009). It is unlikely that all APA professionals from distinct disciplines refer to ICF-CY to set up the intervention plan and advance their services. Conversely, it is possible to use ICF-CY systematically to document the current existing literature on the various intervention goals of APA and this has been conducted by evaluating goals for children (Rainey *et al.* 2014).

This study aims to identify and review characteristics (study and participant characteristics) and program descriptions, and primarily synthesizes information relating to the goals of current APA interventional studies for children and youth with disabilities. To achieve the study aims, the following research questions will be addressed:

- 1) What are the characteristics (in terms of study characteristics and participant characteristics) of current APA interventional studies for children and youth with disabilities?
- 2) What are the program descriptions of current APA interventional studies for children and youth with disabilities?
- 3) What kinds of abilities and behaviors do the current APA interventional studies for children and youth with disabilities focus on (using ICF-CY)?

- 4) To what extent are current APA interventional studies for children and youth with disabilities reported as beneficial or effective?

Methods

Search strategy

A literature search was performed using two procedures. In Procedure 1 (Figure 1), electronic databases Scopus and EBSCO ALL (with overall 70 databases) were used on June 4, 2020. The search strategy was probing within the abstract of articles containing 'Adapted Physical Activity' and 'disabled or disability or disabilities or impaired or impairment' and 'youth or young or teenager or child or children or adolescent'. It was also crucial to review four journals listed on the International Federation of Adapted Physical Activity (IFAPA) official website. Despite these being included in the electronic databases Scopus and EBSCO ALL, data describing the year of publication is limited and not always complete. Procedure 2 was carried out to ensure that intervention studies from the four mainstream APA journals listed on the official website of IFAPA during the time the search was performed are not missing from the search. In Procedure 2 (Figure 2), the manual-search method was applied to and performed on two APA journals: *Adapted Physical Activity Quarterly* and *European Journal of Adapted Physical Activity*. A keyword search was used for the online databases of the other two APA journals; namely,

PRISMA 2009 Flow Diagram for Procedure 2

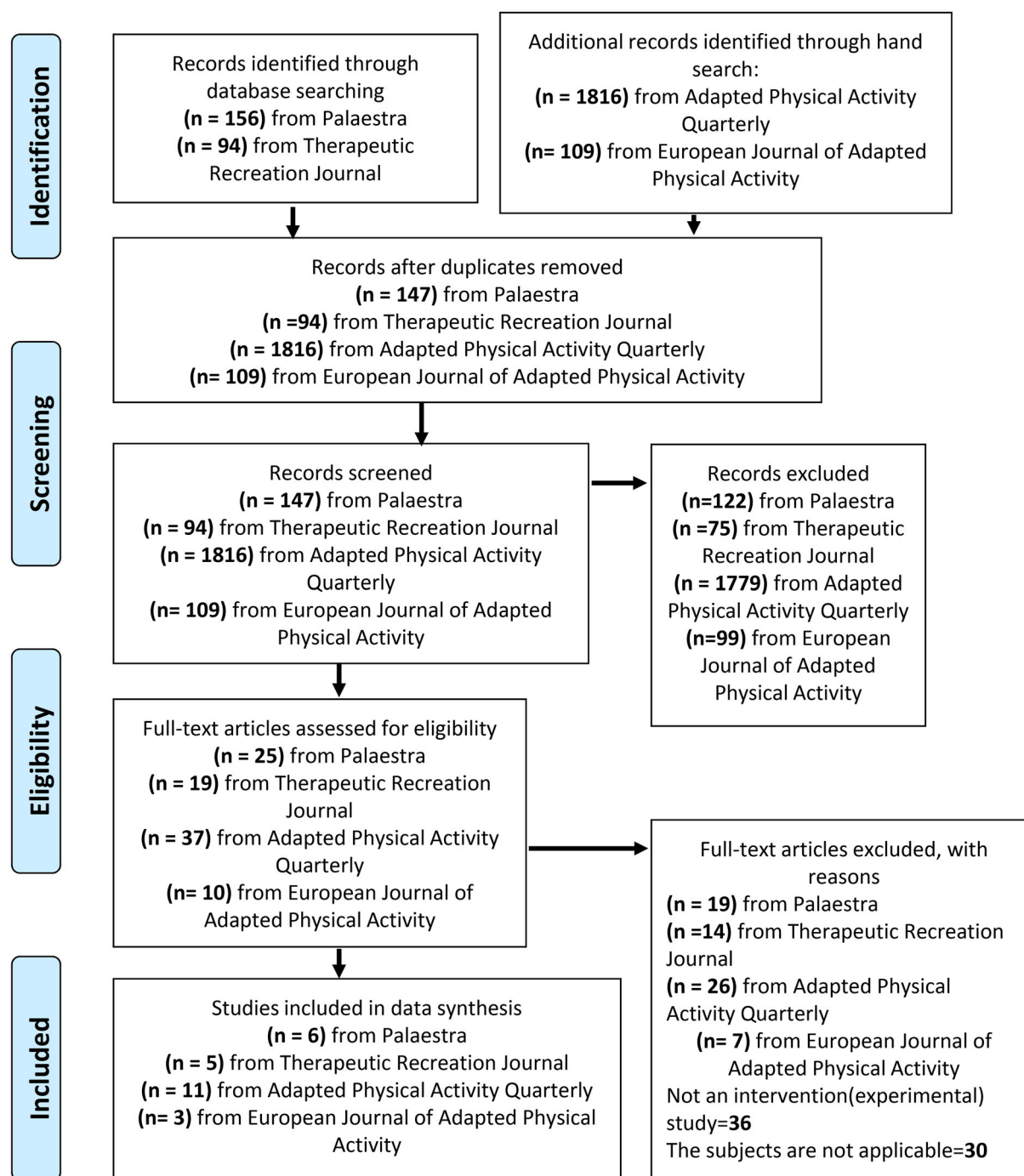


Figure 2. A summary of the screening process for procedure 2.

Palaestra and Therapeutic Recreation Journal. The keywords ‘intervention/interventions’ and ‘children, youth, or children’ and PUBID (32045) were searched in the Palaestra (accessed electronically via ProQuest Central from 1997 to 2019). *Therapeutic Recreation Journal* was accessed electronically via ProQuest Central from 1998 to the latest issue Third Quarter 2020, 54(3). The search strategy was changed to use keywords (‘intervention or interventions’ and PUBID (5997)) and ‘children with disabilities or youth with disabilities’ and ‘adapted physical activity’.

Inclusion and exclusion criteria

Criteria for study selection are as follows: (1) A considered article must be in English; (2) The article must be an intervention or service delivery research and the study design has to be an experimental study; (3) The intervention/service delivery recipients must be children or youth aged 5–18 with disabilities and not their parents or teachers (such that the outcome variables are measured from the children/youth); and, (4) The article must have been peer-reviewed. Included and excluded criteria are mentioned in Table 1.

Table 1. The included and excluded criteria.

	Included criteria	Excluded criteria
Population	• Children and youth, 5–18 years of age with disabilities	• Pre-school populations of children (4 years of age and younger), and parents and teachers
Intervention	• Single or multicomponent interventions in any settings	• N/A
Study design	• An experimental study	• N/A
Publication type	• Peer reviewed journal article	• Conference abstract, study protocol, report, dissertation, book
Publication year	• Till 2020 June	• N/A
Language	• English	• All other languages

Study selection

Following the four stages (identification, screening of title and abstracts, eligibility, and inclusion) of the PRISMA guidelines on the selection process, authors identified a certain number of papers by searching the databases at the first stage. In the second stage, three authors screened all titles and abstracts from the above, removing duplicates. The relevance of the studies was further examined at the third stage, where the same three authors read the full text of each article obtained from the previous stage. As a result, 35 studies were included.

Data synthesis strategy

The studies that met the inclusion criteria are summarized in Table 2, and provide a systematic overview of our current findings. The combination of included studies was reorganized and analyzed in relation to the research questions. A summary of each study is presented in Table 2, with reference to the following aspects: column 1: study origin and characteristics, such as author(s), year of publication, country, and study design; column 2: participant characteristics: the number, age of the participants; the original wording of the type of disabilities was maintained; (column 1 and column 2 contribute to the answers to the first research question relating to the characteristics); column 3: physical activities: organized at the individual level or group level, the type of PAs has been used in the study and adaptations were made for the intervention (since all information were summarized in the table, common adaptations for the same type of PA will be highlighted in the result only); column 4: program details: information for settings and schedule of the program were extracted; (column 3 and column 4 contribute to the answers to the second research question relating to the program descriptions); and, column 5: targeted abilities and behaviors, which centered on the goals of the included studies. The goals were coded with reference to each available items in the measurement tools based on the existing ICF linking rules (Cieza *et al.* 2005). Four main domains, namely, body functions, body structure, activities and participation, and environmental factors are classified in ICF-CY. Practically, the ICF-CY is used in intervention studies by researchers focusing on children and youth with disabilities (Cronin

et al. 2020, Pan *et al.* 2019). While summarizing APA interventions from an international perspective, a study (Hutzler and Sherrill 2007) mentioned that the use of WHO terminology may facilitate a common language among APA professionals who cooperate across service delivery programs. To show how the ICF-CY linking rules are applied, an example of the coding process used in this study is described and presented in Table 3. Four steps were undertaken to complete the ICF-CY coding procedure. Two authors (occupational therapists) firstly identified target abilities and behaviors, and then each assessment tool contents were noted down with specific items in accordance with the target abilities and behaviors. Under the ICF-CY coding process column (6 and 7), each specific item of the tool was mapped to the ICF-CY codes one by one (Cieza *et al.* 2005). Any disagreements were discussed, and consensus was achieved. The final summary step was done to list the included code in order of the smaller to larger code, and to ensure that overlapping codes are removed; (column 5, 6 and 7 contributes to the answer to the third main research questions relating to the intervention goals and ICF codes) and, the answers toward the fourth research question relating to the reported effectiveness of APA interventions were marked in column 5: the two authors simply marked positive target abilities and behaviors with a plus mark(+) and negative ones or those without any change with a minus mark (–) in Table 2.

Results

Characteristics

Study characteristics

Thirty-five included intervention studies were published between 1987 and 2020. The majority (85.71%) were published since 2000. Most (14 studies, 40%) were conducted in the United States, followed by Canada (8 studies, 22.84%); two studies (5.71%) were conducted in China (Hong Kong) and Finland and one study each (2.86%) was conducted in the following countries or regions: Australia, Brazil, France, Germany, Greece, India, Israel, Taiwan and Turkey. Regarding the study design, the largest number of studies consisted of a quasi-experimental design (12 studies, 34.3%) followed by a single-subject study design (11 studies, 31.4%). The number of the randomized controlled trial design

Table 2. An overview of the studies on research questions included in the review.

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, −)	ICF-CY Code Summary (d Activities and e Environmental Factors)
1. Schlieen <i>et al.</i> , Other design, 1987, USA (Schlieen <i>et al.</i> 1987)	Two severely handicapped autistic children (aged 8 years, 5 months and 11 years, 2 months) and 67 non handicapped children (aged 7–12)	Individual and group; cooperative, competitive, individualistic play and games (• Modifications of traditional sports such as volleyball, badminton, soccer, and floor hockey and fundamental movement, gymnastic, and aquatic skills)	Various locations at the university campus; 40-min cooperative sports and game, swimming and gymnastics and 30-min open recreation session once a week, for three weeks	Orientation toward peers and objects (−), Appropriate and inappropriate play behavior (+), Individual target behavior patterns (−)	d720 Complex interpersonal interactions
2. Porretta, Randomized controlled trial, 1988, USA (Porretta 1988)	Forty-Eight mildly mentally handicapped children (ages 8–12)	Group; bean bag tossing (• Greater or smaller contextual interference of four weighted bean bags (85, 128, 142, 184 g))	A typical physical activity setting; each participant had 3 blocks of trials (48 practice trials, 4 transfer trials on the same day and another 4 retention trail after 2 days)	Immediate transfer of tossing skills (+), 2 day retention of tossing skills (+), (Greater contextual interference's leads to better transfer and retention)	b11421 Orientation to others, b1143 Orientation to objects, b1521 Regulation of emotion, b7653 Stereotypes and motor perseveration
3. Revie and Larkin, Randomized controlled trial, 1993, Australia (Revie and Larkin 1993)	Twenty-four children (ages 5 - 9) with poor coordination	Group and individual; overarm distance throw, a hop, target kicking, ball bounce and catch (• The teaching strategies used with logical development of chosen skills, • Presentation of the skill involved auditory, visual, and tactile modes, • Feedback and opportunity for practice of efficient movement patterns)	No information for the settings; 1 h, 1) a 10-min group warm-up, 2) 20-min specific task teaching (10 min for each task: overarm distance throw, a hop, target kicking, ball bounce and catch, 3) 20-min other movement experiences (e.g. running, skipping), 4) 10-min group games and movement to music; once or twice a week, over 9 weeks	Motor skill: An overarm throw for distance (+), A distance hop (−), Target kicking (+), A bounce-and-catch task (+)	d4351 Kicking, d4454 Throwing, d4455 Catching, d4553 Jumping
4. Silliman and French, Single-subject design, 1993, USA (Silliman and French 1993)	Fifteen youths (ages 10–17) with profound mental retardation	Individual; a kicking task (• Use of Reinforcement: The verbal reinforcement was specific (e.g. "Great, [subject's name], for kicking the ball through the cones"); Music was played when the ball was kicked through the cones)	A residential facility; 15-min each time, three times a day, overall 30 sessions	A gross motor skill: kicking (+)	d4351 Kicking

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -,)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
5. Bar-Eli et al., Randomized controlled trial, 1994, Israel (Bar-Eli et al. 1994)	Eighty adolescents (age approximately 15 years) with behavior disorders	Individual; sit-up trials (• Each subject was given a goal; Long-term goals: each subject was given a goal of 40% higher than his or her previous baseline sit-up score. Long- plus short-term goals: to set short-term goals, an 8% improvement was calculated for each subject. In addition, long-term goals were set for the subjects)	Two "special education" boarding schools; five sit-up trials, twice a week, over the course of 10-week training period	Physical performance (+)	b740 Muscle endurance functions
6. Valentini and Rudisill, Randomized controlled trial, 2004, Brazil (Valentini and Rudisill 2004)	One hundred and four students (ages 5.9 – 10.9) with and without disabilities: 36 having disabilities resulting in a motor delay and 68 as not having disabilities but demonstrating motor delay	Group; fundamental motor skills (FMS) activity: (• FMS activity stations (having multiple levels of task and difficulty).• A variety of ways (e.g. goal driven activities including independent and small group games, movement exploration through trial and error, cooperative and self-competition games)to practice at stations, • An inclusive mastery climate is consisted of a variety of activities as well as chances to choose tasks, establish rules, share decisions, work with partners and/or small groups, participate in a private evaluation of progress and effort, and self-manage the time and pace of the activities)	A classroom setting; 60 min: (1) 10-min intro, (2) 45-min fundamental motor skills (FMS) activity; skill instruction and practice, and (3) 5-min closure, twice a week, 24 sessions during a 12-week	Motor skill performance (+)	d4351 Kicking, d445 Hand and arm use, d4454 Throwing, d4455 Catching, d4552 Running, d4553 Jumping

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)		ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -,)	ICF-CY Code Summary (b Body Functions)	
7. Yilmaz et al., Single-subject design, 2005, Turkey (Yilmaz et al. 2005)	Four boys (ages 7–9) with autism	Individual; fun water activities and instructions for aquatic play skills of kangaroo, snake, and cycling (• A constant time delay (0 s and 4 s delay) procedure was used to teach)	At university indoor swimming pool; one day session only	Aquatic play skills (+)	b176 Mental functions of sequencing complex movements	d455 Moving around
8. Reid and Campbell, Randomized controlled trial, 2006, Canada (Reid and Campbell 2006)	Thirty-one children (ages 8–10) with cerebral palsy	Individual; virtual reality(sport applications like soccer and volleyball; music programs like drums; game-like programs like sharks or juggler) (• Participants could choose the applications to be played)	In a lab; each session lasted for 1.5 h, one session a week for 8 weeks	Upper-extremity movement skills (–), Self-efficacy (–), Self-concept (–)	b1266 Confidence, b1801 Body image, b7600 Control of simple voluntary movements	d140 Learning to read, d145 Learning to write, d150 Learning to calculate, d210 Undertaking a single task, d250 Managing one's own behavior, d4401 Grasping, d7500 Informal relationships with friends, d9200 Play
9. Borremans et al., Quasi-experimental nonequivalent-control-group design, 2009, Finland (Borremans et al. 2009)	Twenty adolescents (mean age 16.8) diagnosed with Asperger syndrome	Group; "Move your body & Stretch your mind" consisted of three main parts: 1) an extra-curricular physical exercise program (activities and games that can be easily transferred towards leisure time (e.g. floor ball, soccer, badminton.) 2) an exercise program with stations focusing on core and stretching (warm-up, core workout and stretching) 3) an aerobic physical activity of choice(e.g. biking, swimming, running, nordic	A sports center (the first part), home (the second part), their own community setting (the third part); 1 h, 3 days a week, 12 weeks	Motor competence (+), Physical fitness (+)	b1470 Psychomotor control, b2351 Vestibular function of balance, b4551 Aerobic capacity, b7101 Mobility of several joints, b7300 Power of isolated muscles and muscle groups, b7354 Tone of muscles of all limbs, b740 Muscle endurance functions, b755 Involuntary movement reaction functions	d4402 Manipulating, d4454 Throwing, d4455 Catching, d4552 Running, d4553 Jumping

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
10. Kelly and Legg, Single-subject design, 2009, Canada (Kelly and Legg 2009)	Six children (ages 8–12) with ambulatory cerebral palsy	walking, aerobics), (* All activities are easily available to the student, and explained in simple text with pictures, • The participants received weekly reminders about their training diaries. • Teachers and guardians were encouraged to contact the primary investigator)	A community recreation center; one hour, three times per week (twice a week children performed an aerobic and PRE workout (a 7–10 min warm-up, a 30 min aerobic activity set, a 20 min PRE circuit, and a 10 min stretch/cool down) and once a week children played in a sport context), for 10 weeks;	Energy expenditure (+), Muscle strength for plantar flexion, knee extension and hip extension (-), Perceived satisfaction and perceived performance of a functional motor goal (+)	d2102 Undertaking a single task independently
11. Mazzoni et al., Wait-list control design, 2009, Canada (Mazzoni et al. 2009)	Forty-six children (ages 6–12) with physical, developmental, and/or emotional/behavioral challenges	Individual; indoor wall climbing (* The goals were individualized based on the first attempt at climbing, • The climber to belayer ratio allowed the goals for each child to be specific to their needs, • Physical assistance with hand-over-hand guidance and verbal cueing, verbal guidance, encouragement to persist with the task were provided)	A commercial indoor climbing facility; one hour, once a week, for six weeks	Self-perception (-), Self-efficacy (+)	b1266 Confidence, b1141 Orientation to place, d4451 Climbing
					d9200 Play, d9201 Sports, d7500 Informal social relationships

(Continued)

Characteristics			Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)		
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -)	ICF-CY Code Summary (b) Body Functions	ICF-CY Code Summary (d) Activities and Participation (e) Environmental Factors	
12. Devine and Dawson, Quasi-experimental pretest-posttest design, 2010, USA (Devine and Dawson 2010)	Thirty-one children (ages 9-18) and adolescents with Craniofacial Differences (CD)	Group; a residential summer camp/team building exercises, non-competitive team-oriented activities and a group challenge day and typical camp activities: horseback riding, archery, camp outs, creative arts, nature activities, canoeing and boating) (• A supportive environment and atmosphere, • Camp staff were trained to use personal first language, empower campers to be independent, use empathy and engage campers socially)	Located at a university based outdoor center; 5 days	Self-esteem (+), Social acceptance (+).	b1266 Confidence	e425 Individual attitudes of acquaintances, peers, colleagues, neighbors and community members	
13. Honkavaara and Rintala, Single-subject design, 2010, Finland (Honkavaara and Rintala 2010)	Two boys (ages 12 and 13) with spastic diplegia and one girl (age 14) with athetoid cerebral palsy	Individual; short term intensive hippotherapy (• Rode without a saddle to maximize the therapeutic effects for the rider • Held a safety belt that was attached around the horse's trunk • Balance activities (releasing grip and holding arms upward, outward) added gradually)	No info for the setting; 25 mins to 40 mins, three times a week, three weeks	Gait functions: Velocity (+), Stride length (+), Cadence (+) (-).	b770 Gait pattern functions		
14. Todd et al., Single-subject design, 2010, Canada (Todd et al. 2010)	Three adolescents (ages 15-17) with severe autism	Individual; cycling (• a self-regulation instructional strategy on sustained cycling which included self-monitoring, goal setting, and self-reinforcement • The participants selected the adapted bicycle or adult tricycle they preferred to ride)	Thirty-one sessions were completed; 12 sessions were held indoors and 19 outside; 30 min, three days per week, 12-week	Sustained physical activity (two of the participants +)		d920 Recreation and leisure, d9201 Sports	

(Continued)

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
15. Wuang <i>et al.</i> , Wait-list control design, 2010, Taiwan (Wuang <i>et al.</i> 2010)	Sixty children (ages 6–8) with autism	Group; a Simulated Developmental Horse-Riding Program (SDHRP) using Joba®, consisted of three sessions: 1) simple limb movements and mat exercises, 2) mounted exercises, 3) a game offered while riding on the Joba® (• A treatment plan was especially designed for each child that incorporated SDHRP activities compatible with the child's interest and current motor function)	The pediatric therapy unit at a university-affiliated medical center; 1 h, 2 sessions per week, 20-week	Motor proficiency (+) Sensory integrative functions (+)	d4402 Manipulating, d4552 Running, d4553 Jumping
16. Casey and Emes, Randomized controlled trial, 2011, Canada (Casey and Emes 2011)	Twenty-eight adolescents (mean age 14.6) with Down syndrome	Group; swim training (be taught only one-stroke, front-crawl, and focused on breathing by emphasizing "1-2-3 Breathe" techniques), (• Motivational reinforcement and physical praise) used, (• Provided a visual image of an on-going sports training environment, • Flutter-boards were provided for assistance, • The load of RMT(respiratory muscle training) involved in learning to breathe was raised incrementally as the study progressed)	A competitive-size, indoor pool; one-hour, three times per week, 12 weeks	Speech Respiratory Variables (SRV), Maximum phonation duration (MPD) (+), Initiation Volume (-), Expired Mean Airflow (-)	b3100 Production of voice, b4402 Depth of respiration

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)		ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -)	ICF-CY Code Summary (b Body Functions)	
17. Sangster Jokić et al., Other design, 2013, Canada (Sangster Jokić et al. 2013)	Ten children (ages 7–9) with developmental coordination disorder (DCD)	Group; self-selected motor activity skills (• The Cognitive Orientation to Daily Occupational Performance (CO-OP), an intervention approach, used to teach, • Traditional session length was shortened, • Self-selection tasks on cards depicting childhood motor activities (such as handwriting, bike riding, or tying a shoelace) according to the child's perceived skill and participation level)	Quiet therapy or study rooms in schools; each session in this study were limited to 30 min, on a twice-weekly basis, overall 10 COOP intervention sessions	Self-regulatory (SR) skills as a mediator to acquire motor skills (+)		d155 Acquiring skills
18. Hawkins et al., Single-subject design, 2014, USA (Hawkins et al. 2014)	Two children (7 years old and 11 years old) with autism spectrum disorder (ASD)	Individual; a mid-size equine-assisted therapy program (warm-up and stretching, riding goals and therapeutic interactions) (• Used an English saddle to provide more challenge. • Cued by horse handler and side walkers)	At the university's equine center; 30 min per riding session, three times a week, for 5 weeks	Gross motor skills (+), Body coordination (+), Strength and agility (+)	b2351 Vestibular function of balance, b730 Muscle power functions, b755 Involuntary movement reaction functions, b760 Control of voluntary movement functions	d4552 Running, d4553 Jumping
19. Salaun et al., Quasi-experimental pretest-posttest design, 2014, France (Salaun et al. 2014)	Twenty-three adolescents with mild intellectual disabilities and obesity (with a mean age of 15.13 years (+/-1.10 years))	Individual; adapted physical activity program (predominantly aerobic) (• The working loads were individualized, gradually increase the duration and intensity of physical activity sessions)	In four specialized school; duration varies 30 mins, 50 mins to 1 h, at least twice a week, a 9-month program	Self-perception (+), Anthropometric measurements and body composition (-)	b1266 Confidence, b1300 Energy level, b1801 Body Image, b530 Weight maintenance functions, b5403 Fat metabolism	
20. Armitano et al., Quasi-experimental pretest-posttest design, 2015, USA (Armitano et al. 2015)	Sixteen children (ages 5–18) with disabilities (included intellectual and learning disabilities, down syndrome, several autism spectrum disorders, microcephaly, global)	Individual; a surfing program (1) paddling; 2) balancing on a surf-board while sitting; laying, kneeling, or standing; catching a wave and riding it into shore in the prone, sitting, kneeling, or standing position; and 4) how to paddle back out through the wave unassisted) (• The	On a beach; a one-hour session, twice a week, for eight weeks	Physiological outcomes: Balance(-), Strength and endurance (+), Flexibility (+), Cardiorespiratory endurance (+)	b2351 Vestibular function of balance, b755 Involuntary movement reaction functions, b730 Muscle power functions, b740 Muscle endurance functions, b7101 Mobility of several joints, b7354 Tone of	

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -,)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
21. Choi and Cheung, Quasi-experimental pretest-posttest design, 2016, Hong Kong (Choi and Cheung 2016)	developmental delays, dandy-walker syndrome, heart defects, and hypothyroidism) Thirty Grade 2 children (ages 7–8) with mild Intellectual Disabilities	progression through the skills were based on each child's individual pace of learning and the goals set by the surf instructors) Group; 12 physical activities:1) hop-leap-jump,2) catch a cuppa ball,3) wonder whacker, 4) simple simon said, 5) pushing for distance, 6)beanbag sorting,7) delivery express,8) copycat,9) Ball on ring,10) passing the basi,11) crossing obstacles,12) cone stacking (• Therapeutic recreation accountability model (TRAM) approach reinforces 'activity analysis, selection, and modification', • Specific cues and prompts, with encouragement. • Activities needed to be further broken down, • Equipment needed to be adapted to aid skill acquisition)	A designated covered area and was delivered after all formal classes were completed at a school; each session was 1 h (warm-up, intervention activities, and cool down), 3 times per week for 8 weeks	Emotional self-control (+), Social interaction (–)	d2401 Handling stress, d250 Managing one's own behavior, d2501 Responding to demands, d7100 Respect and warmth in relationships, d7103 Criticism in relationships, d7202 Regulating behaviors within interactions, d7203 Interacting according to social rules
22. Hayward et al., Quasi-experimental pretest-posttest design, 2016, USA (Hayward et al. 2016)	Eighteen children (a mean age of 9.77 (SD = 2.15) with autism spectrum disorder(ASD) and buddies were comprised of 20 local high school volunteers and five Doctor of physical therapy (DPT) students	Individual and group; soccer program:soccer bowling; kicking soccer balls into a regulation size goal; 15-yard dribbling agility; tunnel soccer; a 30-yard dash; and passing (• Using tokens and picture exchange communication systems (PECS), • Verbal praise for reinforcement, ignoring negative behaviors, • Water breaks after completion of a designed task/skill. • Use of simple and direct verbal commands)	In a community; the outdoor soccer program ran for 90 min (a 5-minute check in, 10-minute warm-up (game of tag, dynamic stretching), 35 min of soccer drills in the form of six stations, 20 min of 3-on-3 soccer games, two 5-minute water breaks, and 10 min of parachute activities to conclude with a fun, socially interactive, group activity;) each session, meeting once weekly for overall six sessions	Basic soccer skills: A 30-yard run (–), A 15-yard agility run (+), Kicking accuracy (+)	d9201 Sports, d4552 Running, d4351 Kicking

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -,)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
23. Henderson et al., Quasi-experimental pretest-posttest design, 2016, USA (Henderson et al. 2016)	Thirty-seven children (ages 5-12) with autism spectrum disorder (ASD)	Group; TGMD-2 motor skills teaching and practice (• The didactic teaching style was augmented with many demonstrations, repetition of cues, and verbal, manual, and physical prompting to elicit performance)	In the gymnasium at a center for children with ASD; 40-minute physical education (warm-up activities, skill development activities) class provided twice a week for six months	The locomotor skills (+), The object control skills (+)	d4552 Running, d4553 Jumping, d445 Hand and arm use, d4455 Catching, d4454 Throwing, d4351 Kicking
24. Lee and Porretta, Single-subject design, 2016, USA (Lee and Porretta 2016)	Two boys (ages 8) with autism spectrum disorder (ASD)	Individual; gymnasium (running, throwing, catching, kicking) and pool (bobbing, blowing bubbles, kicking, back floating, and playing with a ball) (• Verbal and physical prompts)	At a university in a multipurpose room and in a swimming pool; each session lasted 13 to 15 min, one session per day, two to three sessions a week	Stereotypic behaviors (+)	b7653 Stereotypies and motor perseveration
25. Yu et al., Quasi-experimental design, 2016, Hong Kong (Yu et al. 2016)	Thirty-eight children (ages 7-10) with developmental coordination disorders (DCD) and Forty-six children with TD	Group; group-based multi skill fundamental movement skills (FMS) training: Participants in the experimental groups were instructed to practice five skills (i.e. running, jumping, catching, kicking, and throwing) underpinned by error-reduced learning paradigm (• FMS tasks were designed to initially be very easy with the difficulty progressively increasing over time, • To control the task difficulty, either the distance was increased (running, jumping, and catching) or the target area was progressively narrowed (kicking and throwing))	PE classes; 35 min, twice per week, a total of nine sessions over 6 weeks	FMS proficiency (+), Self-perceived physical competence (+), Physical activity (-), Sleep disturbance(+)	d4 Mobility, d4351 Kicking, d4552 Running, d4553 Jumping, d4454 Throwing, d4455 Catching, d570 Looking after one's health, d5702, Maintaining one's health, d920 Recreation and leisure, d9201 Sports

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
26. Dieringer et al., Single-subject design, 2017, USA (Dieringer et al. 2017)	Five preschool children (ages 5–6) diagnosed with autism spectrum disorder (ASD)	Individual; locomotor and manipulative skills (e.g. running, hopping, crawling, galloping, placing bean bag on specific body part) were taught with three songs chosen from "Greg and Steve's Kids in Motion," a musical group commonly used in movement setting (• A positive and effective learning environment in which instruction was explicit, • The activities were presented via the lyrics of the music or spoken instruction with or without verbal prompts)	The lunchroom at a preschool; four 10-minute sessions, per week at the same time each day, at least ten, but no more than thirteen, weeks of sessions	On-task behaviors (+)	d155 Acquiring skills, d161 Directing attention, d2501 Responding to demands, d3101 Comprehending simple spoken messages
27. Guest et al., Quasi-experimental pretest-posttest design, 2017, Canada (Guest et al. 2017)	Thirteen girls with Autism Spectrum Disorder (ages 8–11)	Group; multi-sport camp (active group games, track and field, basketball, soccer) (• Motor skills were incorporated into active group games, • The skills taught progressed in difficulty throughout the week and were implemented into translational sport settings)	At a local school gymnasium with indoor and outdoor activity space; a five full-day camp	Motor skills (+), Physical activity level (-), Physical self-perceptions (+), Adaptive behavior (-), Social skills (+)	d4552 Running, d4553 Jumping, d445 Hand and arm use, d4351 Kicking, d4455 Catching, d4454 Throwing, d710 Basic interpersonal interactions, d720 Complex interpersonal interactions, d729 General interpersonal interactions, other specified and unspecified, d920 Recreation and leisure, d9201 Sports
28. Hauck et al., Quasi-experimental pretest-posttest design, 2017, USA (Hauck et al. 2017)	Twenty-five adolescents (aged 9–18) with down syndrome (DS) and autism spectrum disorder (ASD); cycle	Individual and group; ride a bicycle (• Encouraging words and stickers as well as by facilitating short water breaks • Specially-designed bicycles and standard two-wheeled bicycles were used)	A large indoor space where participants rode the specially-designed bicycles (with non-marking tires) and a large outdoor space (parking lot) where participants transitioned once they graduated to the standard two-wheeled; 75 min each day for five consecutive days	Physiological outcomes: Leg strength (+), Balance (+), Body mass index (-)	b1252 Activity level, b1255 Approachability, b1266 Confidence, b4550 General physical endurance, b730 Muscle power functions
					b730 Muscle power functions, b2351 Vestibular function of balance, b755 Involuntary movement reaction functions, b530 Weight maintenance functions

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -,)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
29. Mische Lawson and Little, Quasi-experimental pretest-posttest design, 2017, USA (Mische Lawson and Little 2017)	Ten children with Autism Spectrum Disorder (aged 5–12)	Individual; sensory enhanced aquatics (• Sensory support (visual and sensory supports, communication strategies, physical supports, modeling), • Social opportunities (e.g. songs and games) at the beginning and end of each lesson)	No info for the setting; 30-minute, eight weekly swimming lessons	Sleep behaviors (+)	b134 Sleep functions
30. Bittner et al., Single-subject design, 2018, USA (Bittner et al. 2018)	Six children (mean age= 7 years, 7 months (SD = ± 1.39) with autism spectrum disorders(ASD)	Individual; the participant selected a skill from TGMD-3 and an instructional protocol (i.e. PTC, EB App, combination) and be taught the selected skill in the selected method (• Verbal instruction with a PTC visual, • Verbal instructions were used and the demonstration consisted of viewing the video modeling skill in the EB App)	A gym; the instructional methods trials were conducted for 15 min per session(one trial for 5 min and overall 3 trials), 3 days a week, for 4 consecutive weeks	Gross motor skills: Horizontal Jump (-), Kick a stationary ball (-), Overhand Throw (-), Dribble (+), Strike off Tee (+), Catch (+), Run (-)	d4553 Jumping, d4351 Kicking, d4454 Throwing, d445 Hand and arm use, d4455 Catching, d4552 Running
31. Kokaridas et al., Single-subject design, 2018, Greece (Kokaridas et al. 2018)	Three male children(aged 9)with autism spectrum disorder(ASD) and three without ASD	Individual; climbing program(a 5 min warm up, a 30 min indoor climbing at a traverse and a top-rope route a 5 min cool-down), (• Specific colored tapes that corresponded to specific separate routes of different difficulty level, served as a conditional stimulus that allowed individuals with ASD to discriminate stimulus for the behavior of reaching up and grasping)	A regular rock-climbing gym setting, leisure activity facilitates; 40 min each session at a frequency of two sessions per week, for 12 weeks	Handgrip strength (+), Traverse speed (+)	b7300 Power of isolated muscles and muscle groups d4551 Climbing

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
32. Pritchard Orr et al., Wait-list control design, 2018, Canada (Pritchard Orr et al. 2018)	Thirty children (ages 7–14) with a diagnosis under the (Fetal Alcohol Spectrum Disorder)FASD umbrella	Individual; the FAST Club program(children rotated through a subset of six motor skill stations that were based on the subtests of the motor domains of the BOT-2), (• An individualized PA program based on each child's PA strengths and personalized activity choices)	An elementary school gymnasium; 1.5h per session, 2 sessions per week, 8 weeks	Executive function (+)	b164 Higher-level cognitive functions
33. Ekins et al., Quasi-experimental pretest-posttest design, 2019, Germany (Ekins et al. 2019)	Fifteen children diagnosed with an intellectual disabilities or related developmental disability such as autism spectrum disorder(aged 13.9 ± 2.7)	Group; drumming,the IG conducted two Drums Alive® (the original and researched based brain and body drumming fitness and wellness program applies a multi-disciplinary approach (dance, movement,music, rhythm, modeling and patte) and additionally two conventional physical exercise (PE) classes per week, (• IG combines cognitive experiences with simple dynamic movements and drumming on a fitness (stability) ball, and reinforces rhythm exploration)	In a special school; twice a week for 7 weeks	Cognitive, social and practical competencies (–), Behavior and emotions (–), Motor skills: 20m sprint (–), Sit-ups (+), Standing long jump (+), Forward bend (–), Jumping side-to-side (+), Balancing backwards (+), Medicine ball shots (–), 6 min run (–)	b152 Emotional functions, b140 Attention functions, b152 Emotional functions, b2351 Vestibular function of balance, b4550 General physical endurance, b7306 Power of all muscles of the body, b7355 Tone of muscles of trunk, b755 Involuntary movement reaction functions
34. Mohanty et al., Wait-list control design, 2019, India (Mohanty et al. 2019)	Eighty-three children (ages 9-16) with visual impairment	Group; yoga practices:1) breathing practices,2) loosening practices,3) yoga asanas (postures), 4) pranayama (regulation of breath),and 5) relaxation; (• Audio cassettes with detailed instructions of all practices were also provided)	Residential school; 1 h, 5 days/week, 16 weeks	Muscle strength (+), Flexibility (+), Endurance (+), Coordination (+), Respiratory health (+)	b4402 Depth of respiration, b7101 Mobility of several joints, b7300 Power of isolated muscles and muscle groups, b7354 Tone of muscles of all limbs, b740 Muscle endurance functions, b7602 Coordination of voluntary movements

(Continued)

Characteristics		Program Descriptions		Abilities and Behaviors in Focus (using ICF-CY linking rules)	
Authors, Study Design, Year, Country	Participant Characteristics (n, age)	Physical Activities; (which part is adapted)	Settings; Length, Frequency, Duration;	Target Abilities and Behaviors (+, -)	ICF-CY Code Summary (d Activities and Participation) (e Environmental Factors)
35. Trocki-Ables et al., Single-subject research, 2020, USA (Trocki-Ables et al. 2020)	Five boys (aged 8–11) with autism spectrum disorders(ASD)	Individual; participant completes as many correct 90° push-ups as possible in 1 min, demonstrating correct form, and under three different treatment conditions (• Watched a video of a cross-aged peer performing pushing-up, • Primary reinforcer was given to the participant on completion of the push-ups if the participant matched or improved his previous number of push-ups from his last primary reinforcer session)	In the home setting; 3 baseline trials, 24 randomly assigned treatments, and 1 generalization phase	Upper body strength: Endurance push-up performance (+)	b740 Muscle endurance functions

Table 3. An example of the ICF-CY coding procedure.

Abilities and behaviors in focus (using ICF-CY linking rules)			
Target abilities and behaviors (+, -)	Measurement tools	ICF-CY coding process	ICF-CY code summary
Fundamental motor skills (FMS) proficiency (+)	TGMD-2 (+)	(d4552 Running, d4553 Jumping, d4455 Catching, d4351 Kicking, d4454 Throwing)	b11420 Orientation to self
	locomotor skills (running, jumping) object controls skills (catching, kicking, overarm throwing)		b1266 Confidence b134 sleep functions b1801 Body image b7101 Mobility of several joints b730 Muscle power functions b7354 Tone of muscles of all limbs b7602 Coordination of voluntary movements d4 Mobility d4351 Kicking
Self-perceived physical competence (+)	The Physical Self-Descriptive Questionnaire (PSDQ) (+) physical health, physical coordination, body fat, sporting ability, physical self-concept, physical appearance, physical strength, physical flexibility, physical fitness, and global self-esteem	(d5702 Maintaining one's health, b7602 Coordination of voluntary movements, b1801 Body image, d9201 Sports, b11420 Orientation to self, b1801 Body image, b730 Muscle power functions, b7101 Mobility of several joints, b7354 Tone of muscles of all limbs, d570 Looking after one's health, d920 Recreation and leisure, b1266 Confidence)	d4 Mobility d4454 Throwing
Physical activity (-) Sleep disturbance (+)	GT3x + accelerometers (-) The Children's Sleep Habits Questionnaire—Chinese version (CSHQ-C) (+) bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep-disordered breathing, daytime sleepiness	(d4 Mobility) (b134 Sleep functions)	d4 Mobility d4454 Throwing d4455 Catching d570 Looking after one's health d5702 Maintaining one's health d920 Recreation and leisure d9201 Sports

(6 studies, 17.2%) ranked third. The wait-list control design (4 studies, 11.4%) and other designs (2 studies, 5.7%) contributed to the rest of studies.

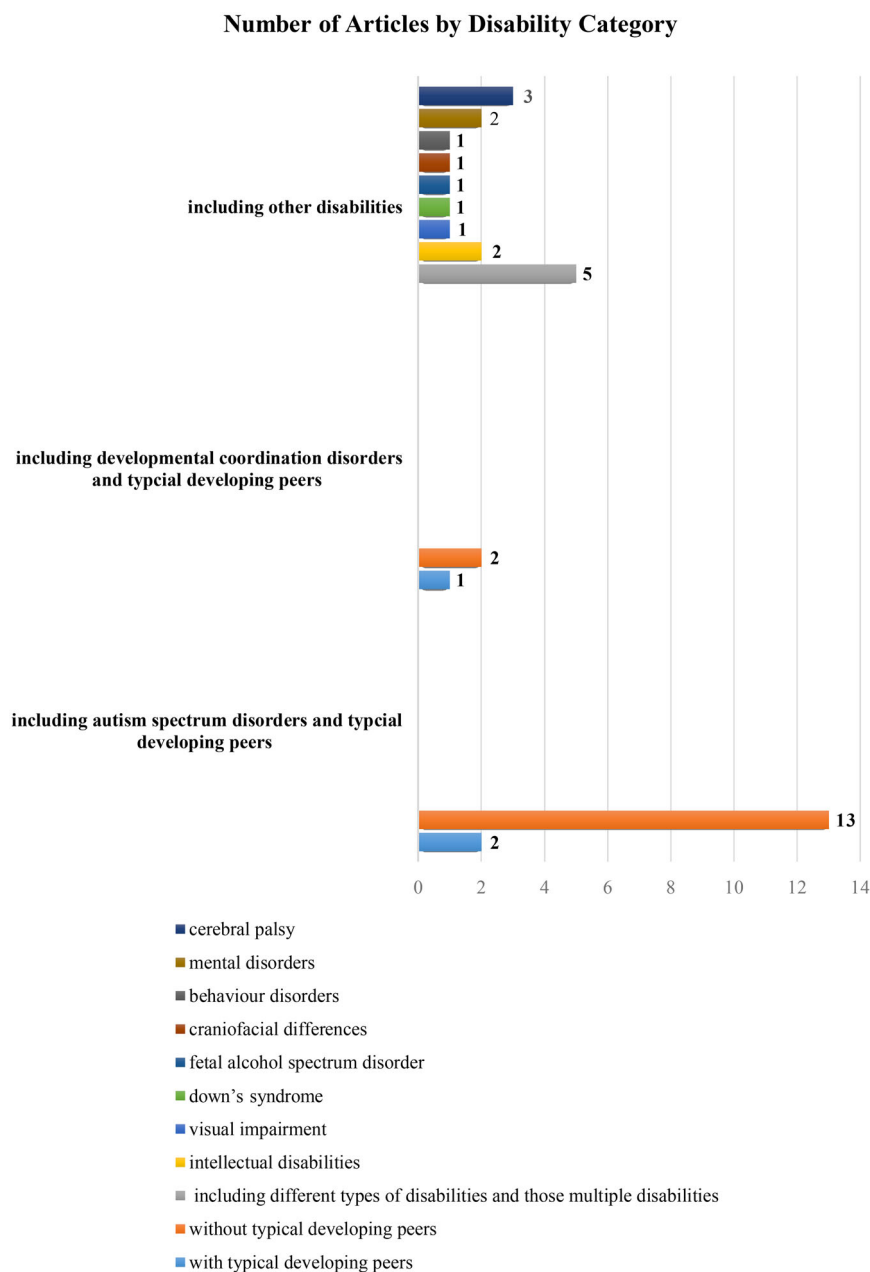
Participant characteristics

Sample sizes across the 35 studies varied from 2 to 104 participants. Regarding the type of disability (Graph 1), the number of studies examining autism spectrum disorders (hereafter abbreviated as ASD) was the highest (15 studies, 42.9%). Particularly, 2 among the 15 studies included both ASD and their typically developing peers. The second most numerous types are composed of those including a group of participants with various disabilities and those with multiple disabilities, consisting of 5 (14.3%) of 35 articles. Three (8.6%) studies examining cerebral palsy and developmental coordination disorders (with 1 among 3 including both developmental coordination disorder (DCD) and their typically developing peers), contributed the third largest share. The number of studies focusing on other disabilities was the fewest, consisting of intellectual disabilities (2 studies, 5.7%), emotional disorders (2 studies, 5.7%), visual impairment (1 study, 2.9%), Down's syndrome (1 study, 2.9%), fetal alcohol spectrum disorder (1 study, 2.9%), craniofacial differences (1 study, 2.9%) and behavior disorders (1 study, 2.9%).

Program descriptions

Types and adaptations of PA

PA in 17 studies (48.6%) was organized at individual levels, while PA in 14 studies (40%) was organized at group levels. The rest of the studies (4 studies, 11.4%) included a combination of both individual and group level PA. Regarding the types of PA, 9 studies (25.7%) used simple motor activities. Simple motor activities, such as a single (bean bag tossing, a kicking task) or a few or a whole set (TGMD-2 and TGMD-3), were used to incorporate motor skills practice/training. The adaptations of simple motor activities were mainly established for: (1) teaching strategies (used with logical development of skills and difficulty increasing over time); (2) providing verbal, musical, visual, tactile reinforcement/prompts; (3) giving children a goal and chance to have autonomy. Seven studies (20%) used a variety of PAs. All wide-ranging PA program details can be found in the Table 2 and two examples are listed here: one study included gymnastics and pool activities and the other included aerobic and strength training and organized sports. No common adaptations were found among them. The number of studies applying equine-assisted therapy (8.6%) and aquatics (8.6%) contributed to 3 of 35 studies. One of the equine-assisted therapy used a horse-riding exercise machine (Joba) instead of



Graph 1. The number of studies by disability category.

real horses. Adaptations for equine-assisted therapy were mostly relevant to the saddle, offering cues by horse handler and side walker, and incorporating balance activities on the horseback. Aquatic programs consisted of basic stroke and breathing training sessions, sensory-enhanced aquatics, and fun water activities with aquatic play skills. Verbal and visual, sensory reinforcement, and modeling, were used for aquatic programs adaptation. Simple tasks (sit-up trails, push-up trails) (5.7%) with adaptations on goal setting, video modeling and personal reinforcement; indoor wall climbing (5.7%) with adaptations on physical assistance and verbal cueing); biking (5.7%) with adaptations on specially designed bikes, and camping (5.7%) with adaptations on creating supportive environment were used in 2 studies each. The remainder of the studies

used yoga (1 study, 2.9%), surfing (1 study, 2.9%), soccer programs (1 study, 2.9%), drumming (1 study, 2.9%), and virtual reality PA (1 study, 2.9%).

Settings

Among the 35 studies, the largest number of studies (19 studies, 54.3%) were conducted in community and recreational settings, which varied from campsites, swimming pools, equine centers, gym/fitness centers, beaches, cycling courses and indoor and climbing facilities. This was followed by those conducted in school settings (11 studies, 31.4%). However, it is important to mention that even though some interventions were held at schools or universities, the intervention itself was not part of a school-sanctioned activity. These activities were neither part of the school curriculum nor were

they conducted in a school classroom. For example, one activity was held in the school after the formal class ended as part of an after-school activity. Alternatively, in the original articles, the setting was described as ‘in quiet therapy or study rooms in schools,’ or ‘in the lunchroom’. Overall, four studies were conducted in similar situations. Nevertheless, school settings play an essential role. There were two articles (5.7%) which fell under the “no information” category, which was the third largest, followed by other settings (2 studies, 5.7%) and clinic (1 study, 2.9%). The other settings included settings in a laboratory or at home.

Program length, frequency and duration

Program length ranged from one trial (without specific length mentioned) or a minimum of 10 min to a maximum of 90 min. The most common length is 1 h (9 studies, 25.7%). Program frequency ranged from only one main trial to 5 days a week. The most common frequency is twice a week (10 studies, 28.6%), followed by three times a week (9 studies, 25.7%), and once a week (5 studies, 14.3%). Program duration ranged from 1 day to 9 months. Twenty studies’ (57.1%) duration fell within the range of 5 weeks to 12 weeks.

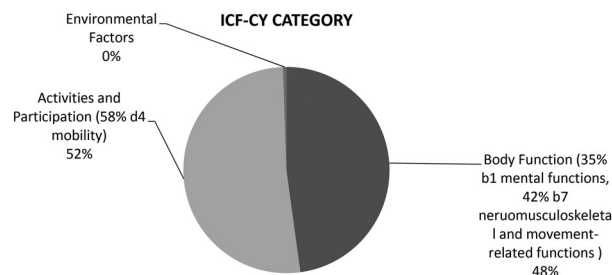
Abilities and behaviors the studies focus on and reported effectiveness

Due to the prevalence of a large variety of research designs, an article could have more than one research purpose. Among the 35 articles, 184 outcomes were identified (Graph 2). Of these, 88 (around 48%) aimed at improving body functions, while only 1 outcome

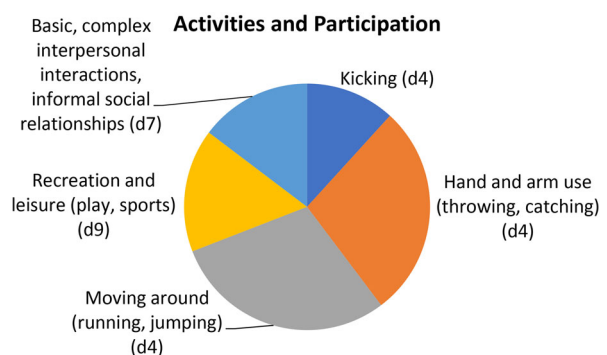
(0%) was focused on the environmental factors. The largest number (95), accounting for 52% of the overall outcomes, fell under the ‘activities and participation’ category. Apparently, the only category not mentioned in the ICF-CY is body structures.

The first conclusion this study can draw is that changing or improving body structures is not one of the main outcomes associated with services to children and youth with disabilities. In the category of body functions (Graph 3), most body functions aimed at improvement were neuromusculoskeletal and movement-related functions, followed by mental functions, and then, sensory functions and pain. It is clear that: (1) Muscle power functions were the main focus among the neuromusculoskeletal and movement-related functions, and it reinforces functions related to the force generated by the contraction of a muscle or muscle groups. The mobility of joint functions, muscle endurance functions, involuntary movement reaction functions, control of voluntary movement functions also played important roles; (2) Confidence building, orientation functions, emotional functions, body image were the highlights among the ‘mental functions’; and, (3) Vestibular function of balance was the most significant goal in the category of ‘sensory functions and pain’.

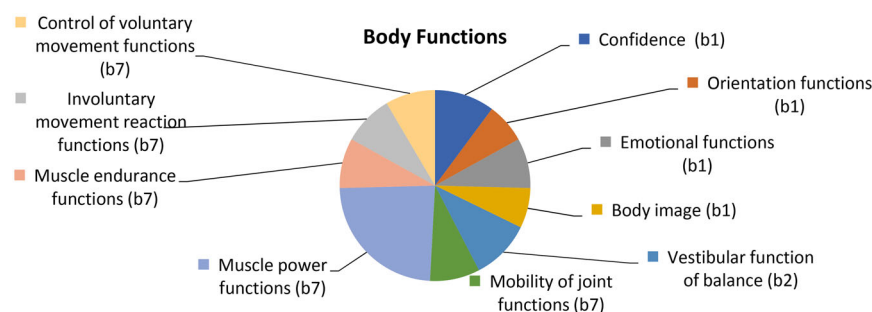
The authors further discussed the components contributing to mobility, interpersonal interactions and relationships and community, social, and civic life under the category of ‘activities and participation’ (Graph 4). Mobility had the largest number of components. Improving the skills of kicking, hand, and arm use



Graph 2. A summary of key outcomes by linking to the ICF-CY category.



Graph 4. A summary of key outcomes under the activities and participation category.



Graph 3. A summary of key outcomes under the body function category.

(throwing, catching), moving around (running, and jumping) are the main outcomes. When it came to interpersonal interactions and relationships, the results showed that most APA articles examined the basic, complex, and general interpersonal interactions, formal and informal relationships. In regards to the community, social, and civic life, only recreation and leisure (play and sports) have been included within the 35 APA articles.

Only 1 outcome item was related to environmental factors. In the category of environmental factors, the outcome was to change attitudes (individual attitudes of acquaintances, peers, colleagues, neighbors and community members).

Overall, the main outcomes associated with APA services to children and youth with disabilities were improving body functions, especially mental functions (confidence, orientation functions, emotional functions, body image), sensory functions and pain (vestibular function of balance), movement functions (control of voluntary movement functions, involuntary movement reaction functions) and muscle functions (muscle power and endurance functions). These also aim to improve the gross and fine motor skills of kicking, hand and arm use (throwing and catching), running, jumping and building informal social relationships, and taking part in recreation and leisure activities (play and sports).

Regarding the reported effectiveness, a large majority (19 studies, 54.3%) of the studies reported positive benefits or effectiveness of APA interventions (Table 2). In another 42.9% (15) of the studies, partial effectiveness was found (e.g. in some behaviors and/or abilities in some participants). One study (2.9%) reported that the virtual reality of sport applications, music programs and game-like programs are no more effective than regular physical therapy or occupational therapy intervention for children with cerebral palsy. As a result, all but one study showed effectiveness or partial effectiveness of APA on improving the abilities and behaviors for children and youth with disabilities.

Discussion

The aim of this scoping review was to identify and review the current existing literature on APA interventions (characteristics, program descriptions, and goals), and to understand how APA has been implemented in different services in relation to 5–18 years old children and youth with disabilities (excluding pre-schoolers). Peer-reviewed journal articles describing interventional programs with an experimental study design written in English were screened. A narrative synthesis was undertaken to answer the research questions on characteristics, program descriptions and goals of APA interventions (abilities and behaviors the studies focus on and reported effectiveness). The ICF-CY linking rules were applied to synthesize the goals.

Characteristics (study characteristics)

Thirty-five articles were found that met the inclusion criteria between the years of 1987 and 2020. Similar with previous studies in out-of-school contexts (Arbour-Nicitopoulos *et al.* 2018, Orr *et al.* 2021), a majority of the included studies were published since 2000. The research comes from different countries and continents, with a big concentration in the United States and Canada. APA started in the United States with its first implementation at the Perkins School for The Blind in Boston in 1838 (Winnick 2010). Three mainstream journals included in our search are based in the United States. It is thus not surprisingly to see that a majority of the studies have been conducted in North America. In 1984, it was suggested that the individualized nature of instructional programs for the mentally handicapped often makes group designs inappropriate in PA research (Watkinson and Watson 1984). It is still the case in the 21st century as our search identified a big portion of single-subject study which thinks highly of individualization in the included studies. As per our findings, even in controlled trials, the PA offered to all children or youth with disabilities in the intervention group can still be provided in an individual context rather than in a group-based format.

Characteristics (participant characteristics)

Children and youth with ASD contributed to the largest target group in the existing APA interventions literature. Expanded diagnostic criteria, more awareness of ASD, and diagnosis occurring at earlier ages led to the prevalence of ASD as a categorical diagnostic condition (Matson and Kozlowski 2011). It was indicated that, within the last two decades, interest in the potentially beneficial effects of PA has grown for children with ASD, even though PA is usually not regarded as a standard treatment/intervention (Sowa and Meulenbroek 2012). Fifteen studies focusing on ASD proved to have an overall/partial positive effectiveness on various outcomes, but this study cannot simply draw a conclusion that APA is more beneficial to children with ASD than the other subgroups. This topic needs further examination. However, this study attests to the fact that researchers in recent decades have realized the potential benefit that PA might bring to children and youth with ASD. Different types of disabilities and children and youth with multiple disabilities contributed to the second largest target group. As discussed with respect to the study design, APA reinforces individualized nature of instructional programs. ASD and different types of disabilities or multiple disabilities, which indicate more complex conditions than other types of disabilities, are more likely to be dealt with individually in the field of APA.

Program descriptions

In terms of the types of PA, this study tried to identify whether the program is organized at an individual level or as group-based level, and the PAs which have been used for the intervention. Not surprisingly, the number of individual-level PAs is bigger than group-level activities. It is understandable that special needs can be better fulfilled in individual programs. A previous meta-analysis for children with ASD study provided proof for that (Sowa and Meulenbroek 2012). However, it is worthy to consider how APA could be organized in a group format to include a larger sample size and still be effective (Lai et al. 2020). The current review covered a wide range of APA intervention studies by implementing rich and diverse adaptive PA programs. Simple motor activities and a variety of PAs were priority selections. In accordance with previous finding (Lai et al. 2020, Orr et al. 2021) on modifications of PA, the descriptions in our findings are also very limited. With adequate modifications information, more PA evidence-based strategies for a certain type of disability (Knight et al. 2015) can be developed. Therefore, a call for more transparent program descriptions regarding modifications in APA is needed. Concerning settings, studies conducted both in-and-out of the school settings and even school-based ones are not school-sanctioned but community-embedded activities (Lai et al. 2020). Regarding the program dose, the average duration of the program is shown to be similar (5 weeks to 12 weeks) as the previous reviews for children with physical disabilities and children with impairments in social skills and cognition (Arbour-Nicitopoulos et al. 2018; Orr et al. 2021).

Abilities and behaviors the studies focus on and reported effectiveness

Using ICF-CY linking rules to synthesize outcome items allows: (1) content comparison of outcome items used in APA with details in a systematic way and (2) guidance on selecting the most appropriate intervention goals.

Content comparison of outcome items used in APA with details in a systematic way

One of the previous reviews for children and youth with physical disabilities simply listed discovered outcomes, which were mainly related to social skills, physical skill development, psychological well-being, and participation in PA (Arbour-Nicitopoulos et al. 2018). Another for children and youth with impairments in social skills and cognition included (Orr et al. 2021) anthropometrics and fitness, motor, and sport skills, psychological well-being, and socialization. The above outcome areas were derived from reviewers' categorization of the associated findings. Without a framework, it

is difficult for the readers to capture which specific aspects of the mentioned outcome areas were examined and the portion and the level of importance of the specific aspects compared to others. However, mapping these factors to ICF-CY codes give an obvious outline to our findings. Regarding the overlapping outcome areas (social aspects, physical skill development, and psychological well-being) of the two previous studies, the new findings of our review can be explained by differentiating the focus of outcome areas. First, the previous studies mostly covered social skills/relationships. Key findings (Arbour-Nicitopoulos et al. 2018) included studies on peer relationships between the typical developing peers of children and youth with disabilities in terms of increasing social acceptance and disability awareness from the perspective of developing peers. Extra reinforcements were put in place for familial interactions from the viewpoint of parents. As per this review, social skills/relationships are not the most significant outcomes that APA scholars are keen to examine. We discovered that social skills/relationship studies focused not on a particular type of disability. Due to the various types of disabilities, social skills are evaluated by all forms of methodology, ranging from standardized social skills instruments filled by teachers or participants themselves to trained observations either from in-person interaction or recorded videotapes. These focus more on the social skills of the children and youth with disabilities themselves on a particular occasion instead of typical developing peers' opinions, and developing peers are not frequently involved. We coded these mostly in d7 interpersonal interactions and relationships, which reinforces improving interaction skills in a contextually and socially appropriate manner with a goal of being involved in the activities and participation. Second, while fewer studies examined physical skill development (improvements in locomotion, object control, and activity-specific skills) in previous studies, this contributed to the biggest outcome areas (hand and arm use, kicking, jumping, and running, which are necessary for mobility, muscle, and movement functions under the neuromusculoskeletal and movement-related functions) with a mixed focus on both body function and activities and participation in our review. Third, psychological well-being was studied, particularly in the form of self-perceptions (e.g. self-efficacy, autonomy, self-concept, and self-esteem) in the previous review (Arbour-Nicitopoulos et al. 2018). In this review, mental functions consisting of orientation functions, temperament and personality functions, emotional functions and body image played the third most important role in the outcome areas. 'Confidence' was the most frequently counted outcome category. Self-esteem and self-perception were the two main forms of tracing back to the original texts.

Although another review had included systematic reviews, our current scoping review included intervention studies, sharing similarities in the wider coverage of the outcome areas with another review in terms of its outcome areas (Lai *et al.* 2020). These include indicators of fitness (aerobic capacity and muscular strength), physical and cognitive function, body weight and composition, physical development, social skills and relationships and psychological well-being. The first reason for the similarity could be because both these reviews consider the same group of study participants: children and youth with disabilities. Even though our studies did not exclude therapy-based interventions as per the eligibility criteria, we did not end up including many therapy-based interventions. This result is in accordance with the previous review, which excluded all therapeutic studies. We assume this is the second reason behind the similarity. Moreover, compared with results from direct derivation of associated findings without a unified ‘language’, graphs with various ICF-CY levels of codes are easier to refer to.

Guidance on selecting the most appropriate intervention goals

This review identifies the fact that current APA interventional literature providing children and youth with disabilities services works toward a pragmatic direction of supporting children and youth with disabilities to become engaged in PA. Activity is defined as the execution of a task or action by an individual and participation is involvement in a life situation (World Health Organization 2007). To achieve this goal, APA, as a service delivery, has been working mainly toward increasing the mobility. Along with this goal, improving functions of movement and mobility, including functions of joints, bones, reflexes and muscles gains its popularity among APA studies. Other than this, secondary focus of goals on improving social skills on a particular occasion and further encouraging doing sports or being active in play along with mental functions to a lesser extent. Future PA interventions for children and youth with disabilities could be planned based on the current goals (Table 2) to ensure the immediate effectiveness or expanded more on those uncovered or unexplored areas. It is also recommended APA implementers refer to ICF-CY to give intervention descriptions for children and youth with disabilities because we did not find a single study mentioning the use of ICF-CY.

In terms of the reported effectiveness, all but one study considered it beneficial for the abilities and behaviors in question. However, this study simply reviews the result of each included studies without conducting a quantitative analysis. A major concern with the quantitative analysis lies in considerable heterogeneity across the included studies. Without the effect sizes

indicating clearer intervention outcomes, the results of this study should be interpreted with caution. At least our discoveries could provide apparent evidence that children and youth with disabilities showed immediate improvements to outcomes because of the intervention (Lai *et al.* 2020).

Conclusion

Overall, this comprehensive review provides an overview of the characteristics, program descriptions and goals (outcome areas) of APA studies for children and youth with disabilities. In accordance with APA’s holistic definition, this review, with specific characteristics and outcomes, proved that APA started serving one of its target groups—children and youth with disabilities, mainly in North America and from 2000 by working on neuromusculoskeletal and movement-related and mental aspects of body functions mostly and reinforcing the mobility and socialization capacity or participation in everyday activities effectively. The biggest target group involved children and youth with ASD. A majority of the PA interventions were held in recreational and after-school school settings with an average program length of 1 h and frequency of 2 or 3 times a week for duration of 5 to 12 weeks. This review not excluding therapeutic intervention studies or limiting the participants to children and youth with a single type of disability provides APA specialists, researchers and educators a broader overview of interventional studies in the field. Using the ICF-CY linking system also generates systematic insights related to the more specific outcome areas under the three of four major domains: body functions, activities and participation, and environmental factors. This will not only encourage APA practitioners to be more confident when setting a goal for children and youth with disabilities but also provide potential recipients and their parents or families with a more convincing report of wide coverage and precise outcomes of APA services. Finally, professionals across disciplines will develop a better understanding of APA through this review and explore areas for potential cooperation in the future.

Limitation

Like most reviews, eligibility criteria could be a limitation because of the language selection. Selecting studies written in English could be one of the potential reasons for missing important studies in the field.

Acknowledgements

We appreciate Dr. Gregor Wolbring (University of Calgary) and Dr. Qun Fang (Qingdao University) for commenting on this manuscript.

Disclosure statement

The authors report there are no competing interests to declare.

ORCID

Mi An  <http://orcid.org/0000-0002-3289-9984>

Hideki Takahashi  <http://orcid.org/0000-0001-8221-8561>

Randeep Rakwal  <http://orcid.org/0000-0003-0559-8577>

Toshihiro Kato  <http://orcid.org/0000-0002-1468-5405>

References

- Arbour-Nicitopoulos, K. P., Grassmann, V., Orr, K., Mcpherson, A. C., Faulkner, G. E. and Wright, F. V. 2018. A scoping review of inclusive out-of-school time physical activity programs for children and youth with physical disabilities. *Adapted Physical Activity Quarterly*, 35, 111–138.
- Armitano, C. N., Clapham, E. D., Lamont, L. S. and Audette, J. G. 2015. Benefits of surfing for children with disabilities: A pilot study. *Palaestra*, 29, 31–34.
- Aubert, S., Barnes, J. D., Abdeta, C., Abi Nader, P., Adeniyi, A. F., Aguilar-Farias, N., Andrade Tenesaca, D. S., Bhawra, J., Brazo-Sayavera, J., Cardon, G., Chang, C. -K., Delisle Nystrom, C., Demetriou, Y., Draper, C. E., Edwards, L., Emeljanovas, A., Gaba, A., Galaviz, K. I., González, S. A., Herrera-Cuenca, M., Huang, W. Y., Ibrahim, I. E., Jürimäe, J., Kämppi, K., Katapally, T. R., Katewongsa, P., Katzmarzyk, P. T., Khan, A., Korcz, A., Kim, Y. S., Lambert, E., Lee, E. -Y., Löf, M., Loney, T., López-Taylor, J., Liu, Y., Makaza, D., Manyanga, T., Mileva, B., Morrison, S. A., Mota, J., Nyawornota, V. K., Ocansey, R., Reilly, J. J., Roman-Viñas, B., Silva, Da. S., Saonuam, P., Scriven, J., Seghers, J., Schranz, N., Skovgaard, T., Smith, M., Standage, M., Starc, G., Stratton, G., Subedi, N., Takken, T., Tammelin, T., Tanaka, C., Thivel, D., Tladi, D., Tyler, R., Uddin, R., Williams, A., Wong, S. H. S., Wu, C. -L., Zembura, P. and Tremblay, M. S. 2018. Global matrix 3.0 physical activity report card grades for children and youth: Results and analysis from 49 countries. *Journal of Physical Activity & Health*, 15, S251–S273.
- Bar-Eli, M., Hartman, I. and Levy-Kolker, N. 1994. Using goal setting to improve physical performance of adolescents with behavior disorders: The effect of goal proximity. *Adapted Physical Activity Quarterly*, 11, 86–97.
- Bittner, M., Silliman-French, L., Myers, D. and Nichols, D. 2018. Effectiveness of instructional strategies on the motor performance of children with autism spectrum disorder. *Palaestra*, 32, 36–42.
- Björck-Akesson, E., Wilder, J., Granlund, M., Pless, M., Simeonsson, R., Adolfsson, M., Almqvist, L., Augustine, L., Klang, N. and Lillvist, A. 2010. The international classification of functioning, disability and health and the version for children and youth as a tool in child habilitation/early childhood intervention – Feasibility and usefulness as a common language and frame of reference for practice. *Disability and Rehabilitation*, 32, S125–S138.
- Borremans, E., Rintala, P. and Kielinen, M. 2009. Effectiveness of an exercise training program on youth with asperger syndrome./ motorische fertigkeiten junger erwachsener mit asperger syndrom: Eine vergleichsstudie. *European Journal of Adapted Physical Activity*, 2, 14–25.
- Casey, A. F. and Emes, C. 2011. The effects of swim training on respiratory aspects of speech production in adolescents with down syndrome. *Adapted Physical Activity Quarterly*, 28, 326–341.
- Choi, P. H. N. and Cheung, S. Y. 2016. Effects of an 8-week structured physical activity program on psychosocial behaviors of children with intellectual disabilities. *Adapted Physical Activity Quarterly*, 33, 1–14.
- Cieza, A., Szilvia, G., Somnath, C., Nenad, K., Bedirhan, Ü. and Gerold, S. 2005. Icf linking rules: An update based on lessons learned. *Journal of Rehabilitation Medicine*, 37, 212–218.
- Collins, K. and Staples, K. 2017. The role of physical activity in improving physical fitness in children with intellectual and developmental disabilities. *Research in Developmental Disabilities*, 69, 49–60.
- Cronin, A., Mcleod, S. and Verdon, S. 2020. Applying the icf-cy to specialist speech-language pathologists' practice with toddlers with cleft palate speech. *The Cleft Palate-Craniofacial Journal*, 57, 1105–1116.
- Devine, M. A. and Dawson, S. 2010. The effect of a residential camp experience on self esteem and social acceptance of youth with craniofacial differences. *Therapeutic Recreation Journal*, 44, 105–120.
- Dieringer, S. T., Porretta, D. L. and Sainato, D. 2017. Music and on-task behaviors in preschool children with autism spectrum disorder. *Adapted Physical Activity Quarterly*, 34, 217–234.
- Ekins, C., Wright, J., Schulz, H., Wright, P. R., Owens, D. and Miller, W. 2019. Effects of a drums alive® kids beats intervention on motor skills and behavior in children with intellectual disabilities. *Palaestra*, 33, 16–25.
- Guest, L., Balogh, R., Dogra, S. and Lloyd, M. 2017. Examining the impact of a multi-sport camp for girls ages 8-11 with autism spectrum disorder. *Therapeutic Recreation Journal*, 51, 109–126.
- Hauck, J., Jeong, I., Esposito, P., Macdonald, M., Hornyak, J., Argento, A. and Ulrich, D. A. 2017. Benefits of learning to ride a two-wheeled bicycle for adolescents with down syndrome and autism spectrum disorder. *Palaestra*, 31, 35–41.
- Hawkins, B. L., Ryan, J. B., Cory, A. L. and Donaldson, M. C. 2014. Effects of equine-assisted therapy on gross motor skills of two children with autism spectrum disorder. *Therapeutic Recreation Journal*, 48, 135–149.
- Hayward, L. M., Fragala-Pinkham, M., Johnson, K. and Torres, A. 2016. A community-based, adaptive soccer program for children with autism: Design, implementation, and evaluation. *Palaestra*, 30, 44–50.
- Henderson, H., Fuller, A., Noren, S., Mortensen Stout, V. and Williams, D. 2016. The effects of a physical education program on the motor skill performance of children with autism spectrum disorder. *Palaestra*, 30, 41–50.
- Hinckson, E. A., Dickinson, A., Water, T., Sands, M. and Penman, L. 2013. Physical activity, dietary habits and overall health in overweight and obese children and youth with intellectual disability or autism. *Research in Developmental Disabilities*, 34, 1170–1178.
- Honkavaara, M. and Rintala, P. 2010. The influence of short term, intensive hippotherapy on gait in children with cerebral palsy./ der einfluss von kurzzeit-intensiv-hippotherapie auf den gang von kindern mit cerebralparese. *European Journal of Adapted Physical Activity*, 3, 29–36.
- Howells, K., Sivaratham, C., May, T., Lindor, E., McGillivray, J. and Rinehart, N. 2019. Efficacy of group-based organised physical activity participation for social outcomes in children with autism spectrum disorder: A systematic review and meta-analysis. *Journal of Autism and Developmental Disorders*, 49, 3290–3308.
- Hutzler, Y. and Sherrill, C. 2007. Defining adapted physical activity: International perspectives. *Adapted Physical Activity Quarterly*, 24, 1–20.
- Hwang, A. -W., Liao, H. -F., Granlund, M., Simeonsson, R. J., Kang, L. -J. and Pan, Y. -L. 2014. Linkage of icf-cy codes with environmental factors in studies of developmental outcomes of infants and toddlers with or at risk for motor delays. *Disability and Rehabilitation*, 36, 89–104.
- IFAPA. 2014. International federation of adapted physical activity [online]. Available at: <<https://ifapa.net/definition/>> [Accessed 10 June 2021].
- Kelly, M. and Legg, D. 2009. On-land community-based aerobic and strength training program for children with cerebral palsy./ programme d'entraînement en aérobie et sur la force pour des enfants imc, base sur la communauté. *European Journal of Adapted Physical Activity*, 2, 7–20.
- Kilgour, G., Adair, B., Stott, N. S., Steele, M., Hogan, A. and Imms, C. 2022. Do physical activity interventions influence subsequent attendance and involvement in physical activities for children with cerebral palsy: A systematic review. *Disability and Rehabilitation*, 44, 1682–1698.
- King, G., Law, M., King, S., Rosenbaum, P., Kertoy, M. K. and Young, N. L. 2003. A conceptual model of the factors affecting the recreation and leisure participation of children with disabilities. *Physical & Occupational Therapy in Pediatrics*, 23, 63–90.
- Knight, V., Sartini, E. and Spriggs, A. D. 2015. Evaluating visual activity schedules as evidence-based practice for individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 45, 157–178.
- Kokaridas, D., Demerouti, I., Margariti, P. and Krommidas, C. 2018. The effect of an indoor climbing program on improving handgrip strength and traverse speed of children with and without autism spectrum disorder. *Palaestra*, 32, 39–44.

- Lai, B., Lee, E., Wagatsuma, M., Frey, G., Stanish, H., Jung, T. and Rimmer, J. H. 2020. Research trends and recommendations for physical activity interventions among children and youth with disabilities: A review of reviews. *Adapted Physical Activity Quarterly*, 37, 211–234.
- Lee, J. and Porretta, D. L. 2016. The effect of instruction on stereotypic behaviors of boys with autism spectrum disorder: A pilot study. *Palaestra*, 30, 18–22.
- Lobenius-Palmér, K., Sjöqvist, B., Hurtig-Wennlöf, A. and Lundqvist, L. -O. 2018. Accelerometer-assessed physical activity and sedentary time in youth with disabilities. *Adapted Physical Activity Quarterly*, 35, 1–19.
- Matson, J. L. and Kozlowski, A. M. 2011. The increasing prevalence of autism spectrum disorders. *Research in Autism Spectrum Disorders*, 5, 418–425.
- Mazzoni, E. R., Purves, P. L., Southward, J., Rhodes, R. E. and Temple, V. A. 2009. Effect of indoor wall climbing on self-efficacy and self-perceptions of children with special needs. *Adapted Physical Activity Quarterly*, 26, 259–273.
- McDougall, J. and Wright, V. 2009. The icf-cy and goal attainment scaling: Benefits of their combined use for pediatric practice. *Disability and Rehabilitation*, 31, 1362–1372.
- McGarty, A. M. and Melville, C. A. 2018. Parental perceptions of facilitators and barriers to physical activity for children with intellectual disabilities: A mixed methods systematic review. *Research in Developmental Disabilities*, 73, 40–57.
- Mische Lawson, L. and Little, L. M. 2017. Feasibility of a swimming intervention to improve sleep behaviors of children with autism spectrum disorder. *Therapeutic Recreation Journal*, 51, 97–108.
- Mohanty, S., Pradhan, B. and Hankey, A. 2019. Yoga practices as an alternative training for physical fitness in children with visual impairment. *Adapted Physical Activity Quarterly*, 36, 431–446.
- Murphy, N. A. and Carbone, P. S., American Academy of Pediatrics Council on Children with Disabilities. 2008. Promoting the participation of children with disabilities in sports, recreation, and physical activities. *Pediatrics*, 121, 1057–1061.
- Orr, K., Wright, F. V., Grassmann, V., Mcpherson, A. C., Faulkner, G. E. and Arbour-Nicotopoulos, K. P. 2021. Children and youth with impairments in social skills and cognition in out-of-school time inclusive physical activity programs: A scoping review. *International Journal of Developmental Disabilities*, 67, 79–93.
- Pan, Y. -L., Hwang, A. -W., Simeonsson, R. J., Lu, L. and Liao, H. -F. 2019. Utility of the early delay and disabilities code set for exploring the linkage between icf-cy and assessment reports for children with developmental delay. *Infants & Young Children*, 32, 215–227.
- Poitras, V. J., Gray, C. E., Borghese, M. M., Carson, V., Chaput, J. -P., Janssen, I., Katzmarzyk, P. T., Pate, R. R., Gorber, S. C., Kho, M. E., Sampson, M. and Tremblay, M. S. 2016. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism=Physiologie Appliquée, Nutrition et Metabolisme*, 41, S197–S239.
- Porretta, D. L. 1988. Contextual interference effects on the transfer and retention of a gross motor skill by mildly mentally handicapped children. *Adapted Physical Activity Quarterly*, 5, 332–339.
- Pritchard Orr, A. B., Keiver, K., Bertram, C. P. and Clarren, S. 2018. Fast club: The impact of a physical activity intervention on executive function in children with fetal alcohol spectrum disorder. *Adapted Physical Activity Quarterly*, 35, 403–423.
- Rainey, L., Van Nispen, R. and Van Rens, G. 2014. Evaluating rehabilitation goals of visually impaired children in multidisciplinary care according to icf-cy guidelines. *Acta Ophthalmologica*, 92, 689–696.
- Reid, D. and Campbell, K. 2006. The use of virtual reality with children with cerebral palsy: A pilot randomized trial. *Therapeutic Recreation Journal*, 40, 255–268.
- Revie, G. and Larkin, D. 1993. Task-specific intervention with children reduces movement problems. *Adapted Physical Activity Quarterly*, 10, 29–41.
- Salaun, L., Reynes, E. and Berthouze-Aranda, S. E. 2014. Adapted physical activity programme and self-perception in obese adolescents with intellectual disability: Between morphological awareness and positive illusory bias. *Journal of Applied Research in Intellectual Disabilities*, 27, 112–124.
- Sangster Jokić, C., Polatajko, H. and Whitebread, D. 2013. Self-regulation as a mediator in motor learning: The effect of the cognitive orientation to occupational performance approach on children with dcd. *Adapted Physical Activity Quarterly*, 30, 103–126.
- Schleien, S. J., Krotee, M. L., Mustonen, T., Kelterborn, B. and Schermer, A. D. 1987. The effect of integrating children with autism into a physical activity and recreation setting. *Therapeutic Recreation Journal*, 21, 52–62.
- Shields, N., Synnot, A. J. and Barr, M. 2012. Perceived barriers and facilitators to physical activity for children with disability: A systematic review. *British Journal of Sports Medicine*, 46, 989–997.
- Silliman, L. M. and French, R. 1993. Use of selected reinforcers to improve the ball kicking of youths with profound mental retardation. *Adapted Physical Activity Quarterly*, 10, 52–69.
- Sowa, M. and Meulenbroek, R. 2012. Effects of physical exercise on autism spectrum disorders: A meta-analysis. *Research in Autism Spectrum Disorders*, 6, 46–57.
- Steadward, R. D., Wheeler, G. D. and Watkinson, E. J. 2003. *Adapted physical activity*. Edmonton: The University of Alberta Press, Steadward Centre.
- Tantilipikorn, P., Watter, P. and Prasertsukdee, S. 2012. Identifying assessment measures and interventions reported for Thai children with cerebral palsy using the icf-cy framework. *Disability and Rehabilitation*, 34, 1178–1185.
- Todd, T., Reid, G. and Butler-Kisber, L. 2010. Cycling for students with asd: Self-regulation promotes sustained physical activity. *Adapted Physical Activity Quarterly*, 27, 226–241.
- Tonkin, B. L., Ogilvie, B. D., Greenwood, S. A., Law, M. C. and Anaby, D. R. 2014. The participation of children and youth with disabilities in activities outside of school: A scoping review: Étude de délimitation de l'étendue de la participation des enfants et des jeunes handicapés à des. *Canadian Journal of Occupational Therapy*, 81, 226–236.
- Tremblay, M. S., Barnes, J. D., González, S. A., Katzmarzyk, P. T., Onywera, V. O., Reilly, J. J., Tomkinson, G. R. and Global Matrix 2.0 Research Team. 2016. Global matrix 2.0: Report card grades on the physical activity of children and youth comparing 38 countries. *Journal of Physical Activity & Health*, 13, S343–S366.
- Trocki-Ables, P., French, R. and Silliman-French, L. 2020. Effect of video modeling and primary reinforcers on the push-up performance of elementary-aged male students with autism spectrum disorder. *Palaestra*, 34, 22–29.
- Valentini, N. C. and Rudisill, M. E. 2004. An inclusive mastery climate intervention and the motor skill development of children with and without disabilities. *Adapted Physical Activity Quarterly*, 21, 330–347.
- Watkinson, E. J. and Wasson, D. L. 1984. The use of single-subject time-series designs in adapted physical activity. *Adapted Physical Activity Quarterly*, 1, 19–29.
- Wilhelmsen, T. and Sørensen, M. 2017. Inclusion of children with disabilities in physical education: A systematic review of literature from 2009 to 2015. *Adapted Physical Activity Quarterly : APAQ*, 34, 311–337.
- Winnick, J. P. 2010. *Adapted physical education and sport Champaign*. IL: Human Kinetics.
- World Health Organization. 2001. *International classification of functioning, disability and health: Icf*. Geneva: World Health Organization. Available at: <https://apps.who.int/iris/handle/10665/42407> [Assessed 25 December 2022]
- World Health Organization. 2007. *International classification of functioning, disability and health: Children and youth version: ICF-CY*. World Health Organization. Available at: <https://apps.who.int/iris/handle/10665/43737> [Assessed 25 December 2022]
- World Health Organization. 2010. *Global recommendations on physical activity for health*. World Health Organization. Available at: <https://www.who.int/publications/i/item/9789241599979> [Assessed 25 December 2022].
- Wuang, Y. -P., Wang, C. -C., Huang, M. -H. and Su, C. -Y. 2010. The effectiveness of simulated developmental horse-riding program in children with autism. *Adapted Physical Activity Quarterly*, 27, 113–126.
- Yildiz Kabak, V., Ipek, F., Unal, S., Atasavun Uysal, S. and Duger, T. 2021. An evaluation of participation restrictions and associated factors via the icf-cy framework in children with acute lymphoblastic leukemia receiving maintenance chemotherapy. *European Journal of Pediatrics*, 180, 1081–1088.
- Yılmaz, I., Birkan, B., Konukman, F. and Erkan, M. 2005. Using a constant time delay procedure to teach aquatic play skills to children with autism. *Education and Training in Developmental Disabilities*, 40, 171–182.
- Yu, J., Sit, C. H. P., Burnett, A., Capio, C. M., Ha, A. S. C. and Huang, W. Y. J. 2016. Effects of fundamental movement skills training on children with developmental coordination disorder. *Adapted Physical Activity Quarterly*, 33, 134–155.