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Review

Quality of reporting on physical activity content and description of teaching: A scoping review on children with autism

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Abstract: The objective of this scoping review was to provide an overview of the variety and characteristics of publications on physical activity (PA) in studies including children with autism spectrum disorder (ASD), and to evaluate the quality of the available information on PA content and description of teaching. This is important because completeness of intervention reporting holds great value for practitioners, patients, community leaders, and policymakers. The following research questions were answered (i) How is the PA content description completeness according to the 12 items in the Template for Intervention Description and Replication (TIDIeR) checklist? (ii) What teaching methods and styles applied in conjunction with PA are described in the included studies? PRISMA-extension for scoping reviews was used to guide the completion and reporting of the study. Publications reporting on children with ASD participating in PA were included. Data on PA content was collected using TIDieR. A qualitative content analysis guided the data collection on teaching methods and styles. None of the included publications reported on all items in TIDieR. Aspects of teaching was described in 40% of the included publications. The existing literature on the relationship between PA participation and ASD-related symptoms in children is extensive and characterized by variations in design and methods. Reporting according to the TIDieR was generally incomplete, and descriptions of teaching could benefit from added detail regarding teaching methods and styles.

Keywords: intervention reporting; teaching methods; teaching styles; TIDieR

Introduction

Autism Spectrum disorder (ASD) causes developmental disabilities and associated health-related and academic challenges (American Psychiatric Association, 2013; MacDonald et al., 2013). Fortunately, several systematic reviews and meta-analyses have documented the positive effects of physical activity (PA) on many of the disabilities associated with ASD (Bremer et al., 2016; Craig, 2021; Ferreira et al., 2019; Healy et al., 2018; Lang et al., 2010; Petrus et al., 2008; Sam et al., 2015; Sorensen & Zarrett, 2014; Sowa & Meulenbroek, 2012; Tan et al., 2016; Yang et al., 2015). Studies also show that children with ASD are less physically active in everyday life than children without ASD (Gehricke et al., 2020; Rostami Haji Abadi et al., 2021). Hence a vicious cycle exists since disabilities associated with ASD may also be considered the main barrier to the introduction of PA in everyday life of children with ASD (Brewster & Coleyshaw, 2011; Lamb et al., 2016; Schleien & Miller, 2014; Thompson & Emira, 2011; Vickerman, 2012).

Through appropriate teaching methods and styles, children with ASD may receive adequate support enabling increased participation in PA (Obrusnikova & Dillon, 2011). The available scientific literature on the positive effects of PA among children with ASD should preferably provide an evidence-based starting point to the specialists working with the children. The complete published description of physical activity content and considerations regarding teaching applied in conjunction with physical activity (PA) in children with ASD are essential to diminish barriers to successful implementation (Glasgow & Emmons, 2007; Hoffmann et al., 2014; Taliaferro & Harris, 2014). However, several systematic reviews aimed to investigate the effect of physical activity among children with ASD also noted several limitations in reporting PA among the included studies. Specifically, important exercise prescription parameters were lacking, and information about the applications of teaching methods and styles when working with children with ASD was limited (Lang et al., 2010; Petrus et al., 2008; Thren & Engstrom, 2009).

In 2014 a template for intervention description and replication (TIDieR) was published (Hoffmann et al., 2014). The objective of the template was to improve the completeness of intervention reporting in published studies. By applying TIDieR across studies on PA and children with ASD, insight into the extent of limitations noted by previous reviews may be enhanced. TIDieR consists of 12 items, covering the name of the intervention, the rationale behind the intervention, what was used to complete the intervention, who, how, and where the intervention was provided, when and how many times the intervention was provided, if any individual tailoring of the intervention was carried out if any modifications to the intervention were made during the study and issues regarding adherence. However, considering the needs of children with ASD and the importance of appropriate teaching methods and teaching styles, TIDieR may lack depth (Lamb et al., 2016). Teaching methods relate to the items regarding what was used to complete the intervention, while teaching styles relate to the items on who, how, and where the intervention was provided. Therefore, a qualitative content analysis based on apriori questions may be relevant when evaluating the completeness of PA reporting and the teaching applied in conjunction with the PA.

The objective of this scoping review was to provide an overview of the study variety and characteristics of publications on PA in children with ASD, and to evaluate the quality of the available information on the PA content and description of teaching by answering the following research questions:

- How is the physical activity content description completeness according to the 12 items in the Template for Intervention Description and Replication (TIDieR) checklist?
- What teaching methods and styles applied in conjunction with physical activity are described in the included publications?

Materials and Methods

This scoping review followed the PRISMA Extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018). The following international bibliographic databases were searched to identify publications of relevance: MEDLINE, PsychINFO, AMED, CINAHL COMPLETE, and SPORTDiscus. The national bibliographic databases Bibliotek.dk and SveMED+ were also searched. The search strategies were drafted in cooperation with an experienced librarian, who also exported the final search results to RefWorks and removed duplicates. All searches were performed from inception to 16 August 2018. The final search strategy for MEDLINE can be found in Appendix 1 (Supplementary material). No protocol was registered or published a priori.

The following publications were eligible for inclusion: Theses, protocols, or scientific articles reporting primary research on children with ASD participating in PA, between 3-18 years of age, written in Danish, Swedish, Norwegian, or English. This review defines PA as

all movement that increases energy expenditure, i.e., unstructured activity and more conscious, targeted, regular movement, exercise, or play. PA thus includes a wide range of activities - from sports and exercise to therapeutic interventions and everyday play (The National Board of Health, 2015). Publications were excluded if studies included children with a wide span of diagnoses and those diagnosed with ASD could not be differentiated from the whole sample, if the PA was primarily sedentary, or if the PA included only unilateral movement of either the upper or lower extremities, e.g., meditation and computer gaming.

Titles, abstracts, and the full text of all publications identified in the searches were sequentially evaluated for eligibility. The authors (AB and DR) independently read and assessed the publications according to the eligibility criteria. The process of evaluating publications was piloted using a sample of n=10 publications from the final search. The final decision of inclusion or exclusion was made by comparing the selections made independently by the authors, and any disagreements were resolved by discussion and consensus.

Extraction of data from the included publications was performed using either a study characteristics data form with the aim of providing an overview of the variety and characteristics of the included publications, TIDieR as a framework to evaluate the completeness of the PA content description, or a qualitative question guide specifically developed for the present scoping review to describe considerations available regarding teaching methods and teaching styles in the included publications (Hoffmann et al., 2014).

The study characteristics data form was developed jointly by the authors and pilot-tested before the application. The following key study characteristics were captured: type of literature (peer-reviewed, protocol, thesis), study design, follow-up time (length of intervention or time of observation), sample size, and gender distribution (Hoffmann et al., 2014).

TIDieR is a checklist containing the minimum recommended items for describing intervention and has previously been used to evaluate the completeness of intervention reporting across different study designs (Cotterill et al., 2018; Hoffmann et al., 2014; Kattackal et al., 2020; Meneses-Echavez et al., 2019; Odgers-Jewell et al., 2020). The TIDieR checklist was developed in accordance with the methodological framework suggested by the EQUATOR Network and consists of twelve items described in Hoffmann et al.(Hoffmann et al., 2014; Moher et al., 2010). The authors (AB and DR) independently scored all included publications according to the twelve items in TIDieR. Scoring sheets were compared, and all disagreements were resolved by discussing the content of the respective publications in relation to the specific item in TIDieR on which the authors disagreed. Publications could be scored as fulfilling an item (Yes), missing an item (No), or partly fulfilling an item (Partly).

Data on considerations regarding teaching, including both teaching methods (explaining the exercises or activities, training program, and used tools) and teaching styles (responsibility and role of the specialists involved, communication both verbal and non-verbal and context) were extracted from the included publications through a qualitative assessment inspired by content analysis. The included publications were approached from a hypothetical-deductive standpoint in relation to the questions in Table 1 (Lynggard, 2020). This was to determine if and how the studies described the adaptation of the content to the children with ASD, identifying the teaching considerations they had used to support the children's motivation, behavioral strategies, and participation in the study. Data from the included publications will be presented in narrative format, tables, and figures.

Table 1. Content analysis questions.

Question 1	In the studies which describe considerations regarding teaching methods, do they mention any specific methods aimed to support the children with ASD? Which and how are the methods mentioned in the study?
Question 2	Do the authors indicate a teaching style specific to children with ASD in order to complete the PA in the study? Which and how are the styles mentioned?
Question 3	Are the specialists involved in the PA assigned any specific roles that can support the children with ASD in the study

Results

A total of n=6,082 publications were identified through the international bibliographic database search, and an additional n=62 publications were identified in the national bibliographic database search. After removing duplicates, a total of n=6,071 abstracts were screened, producing the exclusion of n=5,804 publications and leaving n=267 full-text publications to be assessed for eligibility. Assessment of full-text publications resulted in the exclusion of n=186 publications for the following reasons: publication type (n=28), language (n=9), participant age (n=4), type of diagnosis (n=72), not a movement-based activity (n=52), full text unobtainable (n=16), and duplicates (n=5). This left a final sample of n=81 publications in the scoping review. A flow diagram of the selection process is presented in Figure 1.

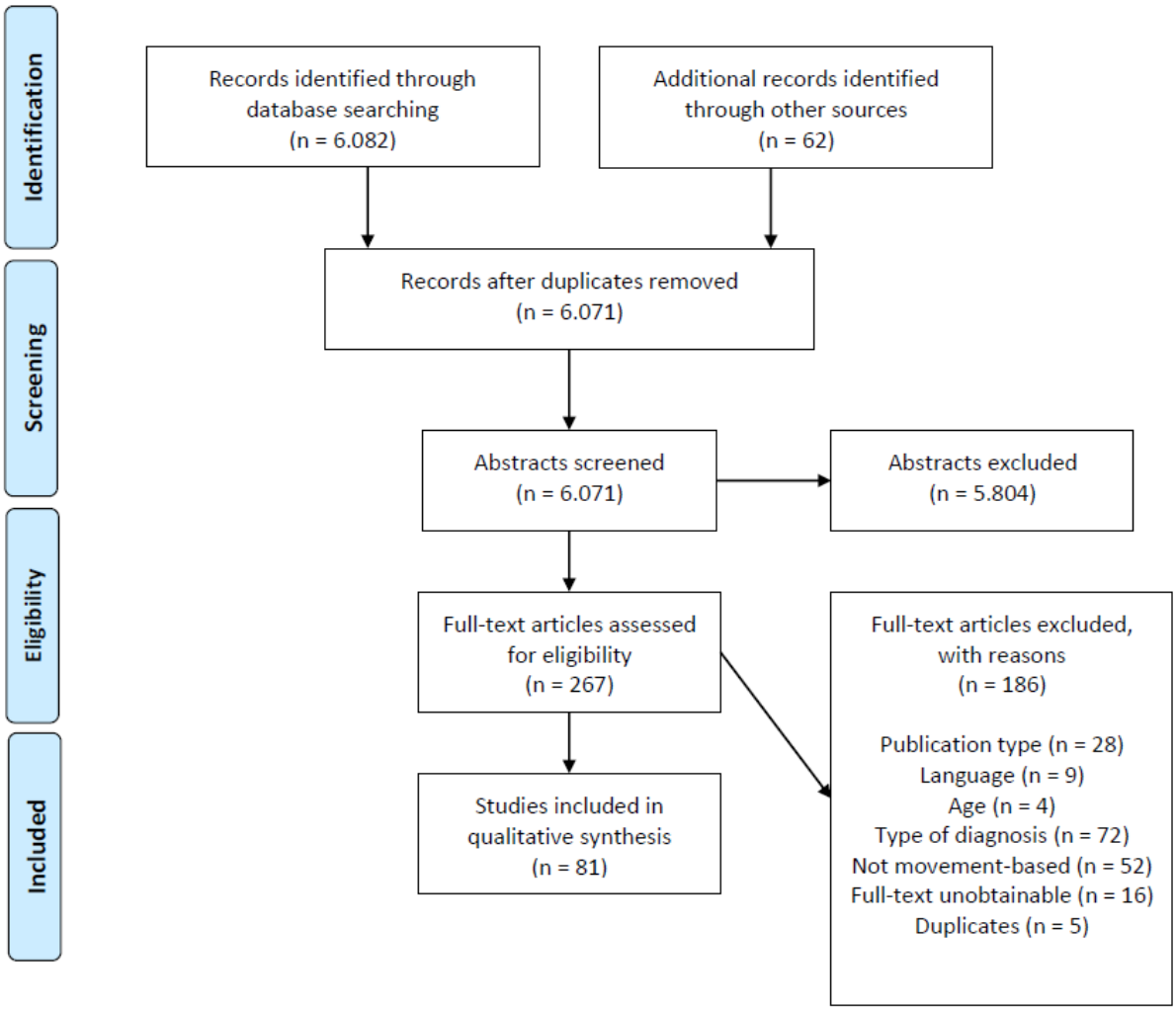

Figure 1. Flow chart of publications identified in the literature search.

Included publications

Most included publications were published in peer-reviewed journals (91%). The remaining publications were published study protocols (3%) and theses (6%). A large variety of study designs was applied across the included publications. However, 12% of the peer-reviewed publications, study protocols, and theses did not explicitly report the type of study design used. Follow-up times were primarily reported in days, weeks, or months and ranged from 5 days to 48 weeks; a few publications reported a follow-up time ≥1 year (Clapham et al., 2018; Morrier & Ziegler, 2018; Ottesen Løgstrup et al., 2017; Roth, 2015). The number of sessions or minutes was also reported as follow-up time (Arnell et al., 2018; Dieringer et al., 2017; Todd & Reid, 2006). However, 11% of the peer-reviewed publications, study protocols, and theses did not explicitly report follow-up time. The sample size was reported in all included publications. Sample sizes ranged from one to 145 children with ASD, among whom the majority were boys (96%). All included publications had either mixed samples or only included boys, except for one study based on a sample of only girls (Guest et al., 2017). Gender distribution, however, was not reported in 10% of the peer-reviewed publications and theses. Information on the type of literature, study designs used, follow-up time, sample size, and gender distribution are presented in Table 2.

Content description according to TIDieR

The average number of items described in the included publications were 6±3 SD (range 0-11). None of the included publications described all 12 items of the TIDieR, but n=3 publications described 11 items (4%) (Alaniz et al., 2017; Ketcheson et al., 2017; Lourenco et al., 2015), and n=10 publications described 10 items (12%) (Bremer & Lloyd, 2016; Clapham et al., 2018; Ferreira et al., 2018; Fragala-Pinkham et al., 2011; Gordon et al., 1986; Hawkins et al., 2014; Ledford et al., 2016; McLaughlin, 2010; Rafie et al., 2017; Toscano et al., 2018). Most publications described intervention item no. 1 (81%), the rationale or the goal of the elements essential to the intervention; item No. 2 (81%), the materials; item no. 3 (64%), the procedures, activities, or processes used in the intervention; item no. 4 (76%), who the intervention provider was; item no. 5 (51%), the modes of delivery; item no. 6 (61%), the type of location; item no. 7 (54%), the number of times that the intervention was delivered, sessions, duration, intensity, or dose; item no. 8 (63%), if the intervention was planned or adapted; item no. 9 (53%), if the intervention was modified during the course of the study; item no. 10 (21%), planned: if intervention adherence or fidelity was assessed; item no. 11 (25%) or actual; if intervention adherence or fidelity was assessed, item no. 12 (16%).

Item no. 8. and no. 5. in the TIDieR were generally only partly described. 24% of the studies were missing information on intensity, duration, or time period in item no. 8 (Anderson-Hanley et al., 2011; Bass et al., 2009; Bremer et al., 2015; Dieringer et al., 2017; Kern et al., 1984; Lee, 2013; Lourenco et al., 2015; May et al., 2018; Mische Lawson & Little, 2017; Moradi et al., 2018; Nelson et al., 2017; Oriel et al., 2016, 2017; Rosenthal-Malek & Mitchell, 1997; Todd & Reid, 2006; Todd et al., 2010; Yu et al., 2018; Zachor et al., 2017) and 11% of the publications were missing information on the intervention providers' education, experiences with the target group or if any special training or certificate was required in item no. 5 (Morrier & Ziegler, 2018; Neely et al., 2015; Pan et al., 2017; Reid et al., 1988; Rosenthal-Malek & Mitchell, 1997; Todd & Reid, 2006; Todd et al., 2010; Toscano et al., 2018; Yanardag et al., 2013). An overview of included publications according to the TIDieR is presented as supplementary material.

Table 2. Included publications.

Study	Type Literature	Study design	Follow-up	Sample (n=)	Boys:Girls
Ajzenman et al., 2013	Peer-reviewed	Single group, pre-post	12 weeks	7	4:3
Alaniz et al., 2017	Peer-reviewed	Single group, pre-post	8-24 weeks	7	6:1
Anderson et al., 2017	Peer-reviewed	Single-subject alternating treatment AB	5-8 days	9	7:2
Anderson-Hanley et al., 2011	Peer-reviewed	Pilot study	2 weeks	22	18:4
Arnell et al., 2018	Peer-reviewed	Qualitative interview	30-80 minutes	24	17:7
Bahrami et al., 2016	Peer-reviewed	Matched pairs RCT	14 weeks	30	26:4
Bass et al., 2009	Peer-reviewed	Two group, pre-post	12 weeks	34	29:5
Bittner et al., 2017	Peer-reviewed	Single group, pre-post	4 weeks	6	5:1
Bittner et al., 2018	Peer-reviewed	Single subject randomized alternating-treatment	4 weeks	6	5:1
Bo et al., 2019	Peer-reviewed	Single group, pre-post	2 weeks	9	9:0
Bremer et al., 2015	Peer-reviewed	Wait-list control experimental design	6-12 weeks	9	7:1[≠]
Bremer & Lloyd, 2016	Peer-reviewed	Mixed methods design	12 weeks	5	4:1
Caputo et al., 2018	Peer-reviewed	Two group, pre-post	9 months	26	17:9
Casey et al., 2015	Peer-reviewed	Multiple-baseline single subject	12 weeks	2	2:0
Cei et al., 2017	Peer-reviewed	Mixed methods	24 weeks	30	NA
Clapham et al., 2018	Peer-reviewed	Case-report	6 years	1	1:0
Dieringer et al., 2017	Peer-reviewed	Multiple-baseline design across participants	49 sessions	5	3:2
Ennis, 2011	Peer-reviewed	Single group, pre-post	10 weeks	6	NA
Ferreira et al., 2018	Protocol	Cross sectional	12 weeks	145	NA
Ferreira et al., 2019	Protocol	RCT	48 weeks	51	NA
Fragala-Pinkham et al., 2011	Peer-reviewed	Non-randomized controlled trial	14 weeks	12	11:1
Goodarzi & Hemayattalab, 2012	Peer-reviewed	RCT	6 months	60	NA
Gordon et al., 1986	Peer-reviewed	Case study – reversal design	12 months	1	1:0
Guest et al., 2017	Peer-reviewed	Quasi-experimental design	8 weeks	13	0:13
Hawkins et al., 2014	Peer-reviewed	Multiple-baseline single-subject design	5 weeks	2	1:1
Hayakawa & Kobayashi, 2011	Peer-reviewed	Single group, pre-post	3 months	23	23:0

Study	Type Literature	Study design	Follow-up	Sample (n=)	Boys:Girls
Hilton et al., 2014	Peer-reviewed	Single group, pre-post	NA	7	5:2
Jafar, 2017	Thesis	AB single-subject design	NA	2	2:0
Kern et al., 1984	Peer-reviewed	Simultaneous-treatment design	NA	3	NA
Kern et al., 1982	Peer-reviewed	NA	NA	7	2:2♀
Ketcheson et al., 2017	Peer-reviewed	Quasi-experimental design	8 weeks	20	15:5
Mische Lawson & Little, 2017	Peer-reviewed	Single group, pre-post	8 weeks	10	10:0
Ledford et al., 2016	Peer-reviewed	Alternating treatment design	3 weeks	2	2:0
Lee, 2013	Thesis	Pilot study + Single-subject multielement design	12 weeks	5	5:0
Lee et al., 2018	Peer-reviewed	Multi-element design	NA	3	3:0
Losinski et al., 2017	Peer-reviewed	Single-case alternating treatment design	10 days	3	3:0
Lourenco et al., 2015	Peer-reviewed	Longitudinal study	20 weeks	17	12:5
MacDonald et al., 2012	Peer-reviewed	NA	5 days	41	NA
MacDonald et al., 2011	Peer-reviewed	Qualitative interview	2 months	9	4:5
May et al., 2018	Peer-reviewed	NA	6 months	34	15:19
Mays, 2013	Thesis	Reversal ABABAB design	30 days	2	1:1
McLaughlin, 2010	Thesis	Reversal design across participants	NA	3	3:0
Melton, 2017	Thesis	Multiple-baseline across participants	NA	4	3:1
Miltenberger & Charlop, 2014	Peer-reviewed	Single-subject multiple-baseline design	NA	3	2:1
Moradi et al., 2018	Peer-reviewed	Random assignment to four groups	2 months	48	48:0
Morrier & Ziegler, 2018	Peer-reviewed	Multiple-baseline across classrooms	23.90 months $^{\mu}$	10	6:4
Najafabadi et al., 2018	Peer-reviewed	Random assignment to two groups	12 weeks	26	NA
Neely et al., 2015	Peer-reviewed	Multi-element design	10-12 weeks	2	1:1
Nelson et al., 2017	Peer-reviewed	Multiple-baseline probe design across participants	NA	3	2:1
Nicholson, 2008	Thesis	Single-subject multiple-baseline design	NA	5	5:0
Nicholson et al., 2011	Peer-reviewed	Multiple-baseline design	10 weeks	4	4:0
Oriel et al., 2011	Peer-reviewed	Within-subjects crossover design	6 weeks	9	7:2
Oriel et al., 2016	Peer-reviewed	ABA withdrawal design	12 weeks	8	5:3
Oriel et al., 2017	Peer-reviewed	Mixed methods	4 weeks	11	7:4

Study	Type Literature	Study design	Follow-up	Sample (n=)	Boys:Girls
Ottesen Løgstrup et al., 2017	Peer-reviewed	NA	1 year	8	NA
Pan, 2010	Peer-reviewed	Within-participant repeated measures	20 weeks	16	16:0
Pan et al., 2017	Peer-reviewed	Single-subject alternating treatment AB	12 weeks	22	22:0
Pitetti et al., 2007	Peer-reviewed	NA	9 months	10	6:4
Pushkarenko et al., 2016	Peer-reviewed	Interrupted time series design ABA	13 weeks	3	3:0
Rafie et al., 2017	Peer-reviewed	Quasi-experimental design	10 weeks	20	11:9
Reid et al., 1988	Peer-reviewed	NA	NA	3	3:0
Rosenthal-Malek & Mitchell, 1997	Peer-reviewed	NA	NA	5	5:0
Roth, 2015	Peer-reviewed	Single case reversal design ABAB	1 year	1	1:0
Schmitz Olin et al., 2017	Peer-reviewed	NA	5 days	7	NA
Shams-Elden, 2017	Peer-reviewed	NA	10 weeks	10	NA
Sotoodeh et al., 2017	Peer-reviewed	Pre-post test study design	8 weeks	29	21:8
Tatsumi et al., 2015	Peer-reviewed	NA	7 days	31	25:6
Todd & Reid, 2006	Peer-reviewed	Changing conditions design	34 sessions	3	3:0
Todd et al., 2010	Peer-reviewed	Multiple-baseline changing criterion design	16 weeks	3	2:1
Todd, 2007	Thesis	Staggered baseline across subjects changing criterion design	4 months	3	2:1
Toscano et al., 2018	Peer-reviewed	RCT	48 weeks	64	NA
Tse et al., 2018	Protocol	RCT	12 weeks	40	NA
Wachob & Lorenzi, 2015	Peer-reviewed	NA	7 days	10	9:1
Watters & Watters, 1980	Peer-reviewed	NA	NA	5	5:0
Yanardag et al., 2013	Peer-reviewed	Pre-test-post-test design	12 weeks	3	2:1
Yilmaz et al., 2004	Peer-reviewed	NA	10 weeks	1	NA
Yu et al., 2018	Protocol	RCT	32 weeks	112	NA
Zachor et al., 2017	Peer-reviewed	NA	13 weeks	51	40:11
Zamani Jam et al., 2018	Peer-reviewed	NA	16 weeks	30	17:13
Zhao & Chen, 2018	Peer-reviewed	Quasi-experimental design	12 weeks	41	29:12

Teaching methods and styles applied

Teaching methods were described in almost half of the publications n=32 (40%), including explanations of the exercises or activities, progression of the training program, and use of tables or pictures to illustrate and explain the exercise or activity. A quarter of the publications n=19 (23%) indicate using tools to support the participation of children with ASD in the physical activity. Most of the tools are visual aids (Bremer et al., 2015; Bremer & Lloyd, 2016; Casey et al., 2015), picture task cards (Bittner et al., 2018; Bremer & Lloyd, 2016), board markers (Pushkarenko et al., 2016), picture exchange communication (physical prompts) to illustrate the activity or exercise (Bremer et al., 2015), and tape and circles to structure the context to play. Other tools mentioned are basic sign language focused on children who are non-verbal (Bass et al., 2009), verbal guiding (Bremer & Lloyd, 2016; Casey et al., 2015), use of music to structure work periods (Dieringer et al., 2017; Mays, 2013), IPad, apps, and video to demonstrate the exercises or activity (Bittner et al., 2018; Melton, 2017).

Teaching styles were only described in a few publications in relation to physical activity n=10 (12%) (Bittner et al., 2018; Casey et al., 2015; Clapham et al., 2018; Ennis, 2011; Gordon et al., 1986; Losinski et al., 2017; MacDonald et al., 2012; May et al., 2018; Miltenberger & Charlop, 2014; Pushkarenko et al., 2016). One study mentions the importance of demonstrating the exercises to the children (Bittner et al., 2018), and two studies included considerations about teaching and behavioral strategies according to the concept of Treatment and Education for Autistic and related Communication-Handicapped Children (TEACCH) (Casey et al., 2015; Pushkarenko et al., 2016). Some publications also mention 'taking by the hand' as an important part of supporting children with ASD (Kern et al., 1984; Reid et al., 1988). The importance of external motivation was only mentioned in very few publications n=9 (11%) (Anderson et al., 2017; Arnell et al., 2018; Bahrami et al., 2016; Bass et al., 2009; Casey et al., 2015; Cei et al., 2017; Ennis, 2011; Ketcheson et al., 2017; Mays, 2013). The type of motivation may be positive verbal feedback and high-fives or hugs (Bahrami et al., 2016; Bass et al., 2009; Casey et al., 2015; Mays, 2013), direct and intensive instructions on movement task (Ketcheson et al., 2017), rewards for completion of the training session by giving extra computer time (Anderson et al., 2017) or preparing the child for the intervention in good time ahead (Arnell et al., 2018). A few publications assigned specific roles to the investigation team or to external persons to provide support to the children with ASD. Only four studies mentioned the number of physical education teachers, trainers, or health professionals necessary per child to complete the PA as described in the studies (Alaniz et al., 2017; Bo et al., 2019; Bremer & Lloyd, 2016; Losinski et al., 2017). Finally, a few publications tasked the parents with the responsibility of maintaining the children's motivation (Bahrami et al., 2016; Cei et al., 2017; Ennis, 2011; May et al., 2018).

Discussion

The systematic search conducted in this scoping review yielded a total of 6,071 potential publications, among which 81 were included. Publications varied greatly in terms of methodology and reporting quality concerning study design, follow-up time, sample size, and gender distribution. The following discussion will address the objective of this scoping review guided by the research questions. Both the completeness of the physical activity content description according to the 12 items in the TIDIeR checklist, and the description of teaching methods and styles applied in conjunction with physical activity. Completeness of intervention reporting holds great value for practitioners, patients, community leaders, and policymakers (Hoffmann et al., 2014). The TIDieR checklist used in the current scoping review revealed that none of the included publications reported on all 12 of the items.

Specifically, information about items related to modification of the study intervention during the course of the study and about intervention adherence was missing in a large proportion of the included publications. Missing information was one challenge identified by using the TIDieR, but the completeness of reporting also includes an adequate and detailed intervention description. Information about who provided the intervention, when the intervention was provided, and how much of the intervention was provided was typically only described in part, leaving out the information necessary to replicate, build on, or make the research findings applicable in daily practice (Hoffmann et al., 2014; Lang et al., 2010). The challenge related to missing or incomplete reporting of interventions is not uniquely associated with literature describing or studying the relationship between PA participation and ASD-related symptoms in children. Multiple studies and systematic reviews have identified similar problems with the reporting quality of interventions within research on cancer (Meneses-Echavez et al., 2019), type 2 diabetes (Odgers-Jewell et al., 2020), and juvenile idiopathic arthritis (Kattackal et al., 2020). This highlights the need for greater attention to this problem from researchers and scientific journals concerning interventions on PA in children with ASD and probably also regarding other ASD treatments (Provenzani et al., 2020). The TiDieR checklist also requires a description of several items regarding the delivery of the intervention (item 3, 4, 5 and 6) (Hoffmann et al., 2014). In the current scoping review, a choice was made to elaborate further on these particular items related to considerations regarding teaching. Because, when working with children with ASD, thorough thinking about how to effectuate the planned intervention in terms of teaching methods and styles often holds additional importance (Lamb et al., 2016; Markkanen et al., 2019; Obrusnikova & Dillon, 2011). Among the included publications describing considerations regarding teaching, the primary information provided related to the support tools applied, whereas a very small proportion addressed initiation, retention, and motivation. Despite limited considerations present in included publications, some take away messages for improving teaching, could be summarized from the publications. The significance of using visual tools, guidelines, and video to illustrate activities, the essential value of asking the children about their wishes, the importance of explicitly describing the role of coaches and parents during training, clear descriptions of verbal instructions, exercises and activities used and how they are adapted to the target group. In this scoping review, we highlight two of the included studies which succeeded in giving the reader a detailed description of thesis considerations (Bremer & Lloyd, 2016; Casey et al., 2015). Thesis studies are valuable in this context because the authors' reflections and knowledge were explicitly described, illustrated, and discussed, allowing the reader to gain insights into and understand the constraints and possibilities in teaching children with ASD. Furthermore, in-depth descriptions strengthen the ability to transfer the study design and intervention to other studies and to daily practice. In the following, we point out some special considerations from the two studies. In the study by Bremer and Lloyd (2016), the authors considered how to include parents in the intervention. They interviewed the PE teachers to gain insight into teaching children with ASD and investigated the perceived impact of the intervention (Bremer & Lloyd, 2016). In the study by Casey et al. (2015), the authors discuss the effect of the teaching styles and strategies they used in promoting adherence to the intervention (Casey et al., 2015). Explicit considerations about teaching methods, teaching styles, and motivation can - in addition to the above remarks - increase both the quality and effect of the outcomes and reduce study dropout (Lamb et al., 2016; Vickerman, 2012). However, a challenge not specifically addressed in this scoping review relates to the heterogeneity in autism severity in the population. When practitioners such as PE teachers, adapted physical educators, physiotherapists, and trainers are planning PA for children with ASD, publications can provide new ideas and support practitioners in their reasoning on

contents and delivery of the PA. However, this can be a challenge if the children's levels of severity are not described in publications or if the authors' reflection on how the PA was adapted to the children's level of severity is missing. Because, transfer of knowledge from publications, guiding practitioners' assessment of the need for adaptation to the group of children with ASD that the practitioners are currently working with is impossible. Further, surveys or interviews focused on children with ASD are often represented by parents, PE teachers, trainers, and health professionals. The reason for this is the role that communication and social deficits plays in autism symptomatology. Recognizing this challenge, a study by (Rasmussen & Pagsberg, 2019) introduced methodological considerations on how to involve children with ASD. To succeed, the researcher should be aware of certain conditions, such as establishing trust, preparing the child for the interview days ahead, and limited questioning (Rasmussen & Pagsberg, 2019). Considering this, one suggestion may be to enhance children's involvement, especially in studies investigating their experiences of PA or their participation in an intervention.

This is the first scoping review to evaluate the quality of the available information on PA content and description of teaching methods and teaching styles within studies, including children with ASD. What constitutes a scoping review and the methodological approach has been discussed in a number of papers (Arksey & O'Malley, 2005; Colquhoun et al., 2014; Levac et al., 2010). Using established methods developed by EQUATOR (Enhancing the QUAlity and Transparency Of health Research) Network, Tricco et al. (Tricco et al., 2018) recently published PRISMA-ScR as an extension for scoping reviews. Based on the definition of a scoping review presented in the PRISMA-ScR, we made a number of conscious choices (Tricco et al., 2018). These choices led us to state two explicit research questions that were used to guide the work and the following discussion. The choices made were based on experiences with the target population and knowledge of the available literature. Furthermore, besides using the PRISMA-ScR in the reporting of the present review, the PRISMA-ScR, in combination with the recommendations made by (Colquhoun et al., 2014), guided the design phase and the work performed in the various stages of the scoping review.

The scoping review methodology applied, and the associated broad focus produced a large body of literature. Even though primarily peer-reviewed articles were included in the scoping review, the search strategy also identified relevant thesis. Furthermore, no restriction on the year of publication was made in the search strategy in an effort not to exclude any relevant literature. Typically, studies summarizing literature using a systematic approach restrict the search strategy on the year of publication, study methodology, or publication type (Bremer et al., 2016; Ferreira et al., 2019; Healy et al., 2018; Lang et al., 2010; Petrus et al., 2008; Sam et al., 2015; Sorensen & Zarrett, 2014; Sowa & Meulenbroek, 2012; Tan et al., 2016; Yang et al., 2015). This was not the case in the present scoping review, which contributes to potential awareness of additionally available literature within the field of ASD and PA.

This scoping review is also the first to apply The TIDieR checklist and guide across publications within the field of research investigating the relationship between PA participation and ASD-related symptoms in children (Hoffmann et al., 2014). However, the TIDieR has previously been applied in a systematic review on pragmatic language interventions within children with ASD (Parsons et al., 2017). Both the EQUATOR Network and the Consolidated Standard of Reporting Trails (CONSORT) advocate the application of the TIDieR, and it is applicable outside the randomized controlled trial context (Cotterill et al., 2018; Hoffmann et al., 2014; Hopewell et al., 2008). The application of the TIDieR in the present review provided a detailed overview of the intervention reporting quality within the field of research in question.

The reviewer team consisted of two authors (AB and DR). Both authors were involved in all methodological choices and stages of the review. However, the size of the team prolonged the review process. Specifically, the inclusion of a third reviewer in the study selection stage would have been beneficial and strengthened the validity of the work (Levac et al., 2010; Tricco et al., 2018). The independent screening of publications, both at abstract and full-text level, produced disagreements resolved through discussion and consensus. However, the process may have been too conservative, favoring inclusion instead of exclusion and thus leading to a high inclusion rate in both screening processes. Therefore, additional screening time has been spent on publications that a third reviewer would possibly have excluded earlier in the study selection stage.

In accordance with the eligibility criteria, only publications in Danish, Norwegian, Swedish, or English were included. However, during the source selection process n=9 publications were identified as relevant based on title and abstract, but full-text versions were only available in either German (Schneider, 1984; Zimmermann, 1978), Turkish (Yanardağ et al., 2009), Romanian (Mohamed, 2017), Russian (Gross et al., 2017), Arabic (Zeidabadi et al., 2013), or Chinese (Yun & Ling-zhi, 2016; Yan et al., 2018; Pan et al., 2018). Therefore, potentially relevant publications have may been excluded due to a language barrier in the review team.

The electronic databases were searched from 16 August 2018 to inception. Since the completion of the literature search, publications of relevance to the aim of the scoping review may have been published.

Conclusions

The existing literature on the relationship between PA participation and ASD-related symptoms in children is extensive and characterized by variations in design and methods. Reporting according to the TIDieR was generally incomplete, and the descriptions of teaching could benefit from added detail regarding teaching methods and styles.

Perspectives

Thesis conclusions have triggered the following key messages for future publications (i) Use the TIDieR or a similar reporting checklist to support an accurate description of the interventions for replicability and in-practice implementation. (ii) Acknowledge the importance of providing the reader with a detailed description of considerations regarding both teaching methods and teaching styles for in-practice implementation. (iii) Future research should consider including thorough descriptions of the heterogeneity in ASD severity among samples of children with ASD. (iiii) Methods generating knowledge based on the child's voice should be considered when children with ASD experiences of PA are an aim of the research.

Supplementary Materials: Table containing each included publication scoring according to TIDieR entitled "Content description according to TIDieR".

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Supplementary material

Supplementary Table 1. Content description according to TIDieR

Study	1	2	3	4	5	6	7	8	9	10	11	12
Ajzenman et al., 2013	Y	Y	Y	Y	Y	Y	P	Y	P	N	N	N
Alaniz et al., 2017	Y	Y	Y	Y	Y	Y	Y	Y	P	Y	Y	Y
Anderson et al., 2017	Y	N	Y	N	N	N	N	N	N	Y	N	Y
Anderson-Hanley et al., 2011	Y	Y	Y	Y	N	P	N	P	N	N	N	N
Arnell et al., 2018	Y	Y	Y	N	N	N	Y	Y	N	Y	N	N
Bahrami et al., 2016	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N	N
Bass et al., 2009	Y	Y	Y	Y	Y	N	N	P	N	Y	Y	N
Bittner et al., 2017	Y	Y	Y	Y	N	Y	N	Y	Y	Y	N	N
Bittner et al., 2018	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y
Bo et al., 2019	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N	N
Bremer et al., 2015	Y	Y	Y	Y	Y	Y	N	P	Y	Y	Y	N
Bremer & Lloyd, 2016	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Caputo et al., 2018	Y	N	Y	Y	Y	Y	N	Y	Y	N	N	N
Casey et al., 2015	Y	Y	Y	Y	N	N	N	Y	Y	N	Y	N
Cei et al., 2017	Y	Y	Y	Y	N	Y	N	Y	Y	N	N	N
Clapham et al., 2018	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Dieringer et al., 2017	Y	Y	Y	Y	Y	P	N	P	N	N	N	Y
Ennis, 2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Ferreira et al., 2018	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Ferreira et al., 2018	Y	Y	Y	Y	Y	Y	Y	P	Y	N	N	N
Fragala-Pinkham et al., 2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Goodarzi & Hemayattalab, 2012	Y	Y	Y	Y	Y	N	N	Y	N	N	N	N
Gordon et al., 1986	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Guest et al., 2017	Y	Y	Y	N	N	Y	Y	N	N	N	N	N
Hawkins et al., 2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	P	N	Y
Hayakawa & Kobayashi, 2011	Y	Y	Y	Y	N	N	N	N	Y	N	Y	Y
Hilton et al., 2014	Y	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y
Jafar, 2017	Y	Y	Y	Y	N	Y	Y	Y	N	N	N	N
Kern et al., 1984	Y	Y	Y	Y	Y	Y	Y	P	Y	N	Y	N
Kern et al., 1982	N	Y	Y	Y	N	N	Y	N	Y	Y	Y	N
Ketcheson et al., 2017	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Mische Lawson & Little, 2017	Y	Y	N	N	Y	Y	N	P	N	N	N	Y
Ledford et al., 2016	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y

Study	1	2	3	4	5	6	7	8	9	10	11	12
Lee, 2013	N	Y	Y	Y	N	N	Y	P	N	N	N	N
Lee et al., 2018	N	Y	Y	Y	N	Y	N	N	Y	N	N	N
Losinski et al., 2017	Y	Y	Y	Y	N	N	N	N	N	N	N	N
Lourenco et al., 2015	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MacDonald et al., 2012	Y	Y	Y	Y	Y	Y	Y	P	P	N	N	N
MacDonald et al., 2011	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	Y
May et al., 2018	Y	Y	N	N	N	N	N	N	N	N	N	N
Mays, 2013	Y	Y	N	N	Y	Y	N	P	Y	N	N	N
McLaughlin, 2010	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Melton, 2017	N	Y	N	Y	Y	Y	Y	Y	Y	N	N	N
Miltenberger & Charlop, 2014	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	N
Moradi et al., 2018	Y	N	N	Y	Y	Y	Y	Y	N	N	N	N
Morrier & Ziegler, 2018	Y	N	Y	P	Y	Y	P	P	Y	Y	N	N
Najafabadi et al., 2018	Y	Y	Y	Y	P	Y	Y	Y	N	N	N	N
Neely et al., 2015	Y	Y	N	P	Y	N	N	Y	N	N	N	N
Nelson et al., 2017	Y	Y	Y	Y	P	Y	Y	Y	Y	N	Y	N
Nicholson, 2008	Y	Y	P	Y	Y	Y	P	P	Y	N	N	N
Nicholson et al., 2011	Y	Y	N	Y	N	N	Y	Y	N	N	N	N
Oriel et al., 2011	Y	Y	N	Y	N	N	Y	Y	N	N	N	N
Oriel et al., 2016	Y	Y	N	P	N	P	N	Y	N	N	N	N
Oriel et al., 2017	Y	Y	N	Y	N	Y	N	P	Y	N	N	N
Ottesen Løgstrup et al., 2017	P	P	N	Y	N	N	Y	Y	N	N	N	N
Pan, 2010	Y	Y	N	Y	Y	Y	Y	P	Y	N	N	N
Pan et al., 2017	Y	Y	P	Y	Y	Y	Y	Y	Y	N	N	N
Pitetti et al., 2007	Y	Y	N	Y	P	Y	N	Y	N	N	N	N
Pushkarenko et al., 2016	Y	Y	N	Y	N	N	N	Y	Y	Y	N	N
Rafie et al., 2017	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y
Reid et al., 1988	N	N	N	P	Y	N	N	Y	N	N	N	N
Rosenthal-Malek & Mitchell, 1997	Y	Y	N	P	P	P	Y	Y	N	N	N	Y
Roth, 2015	N	N	N	Y	P	P	Y	P	Y	N	N	N
Schmitz Olin et al., 2017	N	Y	Y	N	N	Y	Y	Y	Y	N	N	N
Shams-Elden, 2017	N	N	N	Y	N	N	Y	Y	N	N	N	N
Sotoodeh et al., 2017	Y	Y	N	N	N	N	N	N	N	N	N	N
Tatsumi et al., 2015	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	N
Todd & Reid, 2006	P	P	N	N	N	N	Y	Y	N	N	N	N
Todd et al., 2010	P	P	Y	Y	P	Y	Y	P	N	Y	N	N
Todd, 2007	Y	Y	Y	Y	P	Y	Y	P	Y	N	Y	N
Toscano et al., 2018	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Tse et al., 2018	P	P	Y	Y	P	Y	N	Y	N	N	Y	N
Wachob & Lorenzi, 2015	N	N	N	N	N	N	N	N	N	N	N	N

Study	1	2	3	4	5	6	7	8	9	10	11	12
Watters & Watters, 1980	P	Y	Y	N	N	N	N	Y	N	N	N	N
Yanardag et al., 2013	N	N	N	N	N	N	N	N	N	N	N	N
Yilmaz et al., 2004	Y	Y	P	Y	P	Y	Y	Y	Y	N	N	N
Yu et al., 2018	Y	Y	N	N	N	N	N	Y	N	N	N	N
Zachor et al., 2017	Y	Y	Y	P	Y	Y	N	P	Y	N	Y	N
Zamani Jam et al., 2018	Y	Y	P	Y	Y	Y	Y	P	N	N	N	N
Zhao & Chen, 2018	Y	N	N	Y	N	N	N	Y	N	N	N	N

Note. Included publications performance evaluated by the template for intervention description and replication (TIDieR) checklist and guide. Yes item described (Y), No item not described (N), Partial description of item (P). Item 1 "Provide the name or a phrase that describes the intervention", Item 2 "Describe any rationale, theory, or goal of the elements essential to the intervention", Item 3 "Materials: Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed (such as online appendix, URL)", Item 4 "Procedures: Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities", Item 5 "For each category of intervention provider (such as psychologist, nursing assistant), describe their expertise, background, and any specific training given", Item 6 "Describe the modes of delivery (such as face to face or by some other mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a group", Item 7 "Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features", Item 8 "Describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity, or dose", Item 9 "If the intervention was planned to be personalised, titrated or adapted, then describe what, why, when, and how", Item 10 "If the intervention was modified during the course of the study, describe the changes (what, why, when, and how)", Item 11 "Planned: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain or improve fidelity, describe them" Item 12 "Actual: If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as planned".

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Appendix A

Search strategy

((Asperger* OR Autism* OR "Autistic Disorder" OR "Autistic Disorders" OR (Kanner* AND Syndrome*)) OR ("Learning Disorders"[Mesh] OR "Learning Disability" OR "Learning Disabilities" OR "Learning Disorder" OR "Learning Disorders" OR "Learning Disturbance" OR "Learning Disturbances" OR (Developmental* AND Academic* AND Disorder*) OR (Developmental* AND Disorder* AND Scholastic* AND Skill*))) AND ("Adolescent" OR "Adolescents" OR "Adolescence" OR "Child" OR "Children" OR "Minor" OR "Minors" OR Teen* OR Youth*) AND ("Human Activities"[Mesh] OR "Movement"[Mesh] OR Exercise* OR "Human Activities" OR "Human Activity" OR Movement* OR "Motor Activities" OR "Motor Activity" OR "Physical Activities" OR "Physical Activity" OR "Play and Playthings" OR "Playthings and Play" OR "Playing" OR (preschool* AND activit*) OR (recreational* AND activit*) OR (spontaneous* AND activit*) OR "sport" OR "sports")

From 2017/01/01 -> 3000/31/12

(("Autism Spectrum Disorder"[Mesh]) OR ("Learning Disorders"[Mesh] OR "Specific Learning Disorder"[Mesh])) AND ("Adolescent"[Mesh] OR "Child"[Mesh] OR "Minors"[Mesh]) AND ("Exercise"[Mesh] OR "Human Activities"[Mesh] OR "Motor Activity"[Mesh] OR "Movement"[Mesh] OR "Play and Playthings"[Mesh] OR "Sports"[Mesh])