

Collaborative play for autistic children: A systematic literature review

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ABSTRACT

This paper presents a systematic literature review investigating collaborative play for autistic children. Autistic children are often faced with challenges related to social interaction, communication, and interest during play. This underscores the importance of exploring collaborative play as a potential intervention. Collaborative play, where children engage together towards shared goals, offers promising prospects for improving communication abilities in autistic children. To conduct this review, four search engines were utilized, resulting in the identification of 2,452 articles. Through a systematic selection process, the initial pool was narrowed down to 74 articles for further examination, eventually focusing on 14 papers. The findings indicate that various resources and strategies can facilitate collaborative play among autistic children. The review discussed the technologies employed and emphasized the need for regular engagement in collaborative play for autistic children, with the presence of a mediator – often parents or teachers – to support the different actions. The studies highlighted the inclusive environments, where autistic children play alongside their neurotypical peers, fostering social development can be of support. This review sheds light on the critical aspects of collaborative play that have not been adequately studied, providing valuable insights for researchers and practitioners.

1. Introduction

A child's growth cannot be considered complete without play. Wiesberg [1] states that "play" refers to any activity children engage in for entertainment and no other reason. Hirsh-Pasek [2] says that play must meet five criteria: it must be fun, it must not be extrinsic, it must be spontaneous and chosen by the player, it must require some participation from the player, and it must have some element of fantasy. It is evident that for an action to be considered play, it must be enjoyable, child-directed, and devoid of external motivation. Autistic children often display symptoms that make it difficult for them to act independently and have difficulty initiating and maintaining friendships [3]. In general, children need to play as often as possible to build their abilities to become self-reliant adults [4].

Autism, as defined by the American Psychiatric Association, is a neurodevelopmental disease that emerges in early childhood. The Diagnostic and Statistical Manual of Mental Disorders [5] suggests that Autistic children with Spectrum Condition (A.S.C.) may have trouble communicating and socializing with others [5]. While both genetic and environmental factors have been suggested as possible triggers for

autism, the condition's specific causes are still unknown [6]. Autism disorder is diagnosed in boys four times more often than in girls [7]. Children are often diagnosed with autism around the age of four [8]. About 1 in 160 children and teenagers are diagnosed with autism [9]. Autistic children with spectrum disorder typically have challenges with the adaptive skills needed for safe and independent function, which is frequently accompanied by cognitive skill limitations [10]. A person's ability to meet their own needs and respond to social and natural demands and expectations in the environment in ways that are appropriate for their age, social class, and culture is referred to as having "adaptive skills. [11].

To encourage collaborative play, it is crucial to define what is meant by the term "collaboration," which can signify a wide range of concepts depending on the setting. Collaboration, however, can also be understood broadly as the coordination and cooperation of multiple entities toward a single purpose [12]. In addition to dividing up key responsibilities and coordinating between team members, the collaboration also includes sharing knowledge and expertise. Collaboration is an essential skill that children should learn. Scaffolding can function as a mediator and support activities in which children work together to

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accomplish goals positively and productively. [13,14]. According to Davis, [15] children diagnosed with autism often encounter difficulties when it comes to engaging with their surroundings, objects, and individuals in a manner consistent with conventional play patterns. Hence, they frequently demonstrate shortcomings in their play abilities, namely in the areas of symbolic and sociodramatic play [16]. These types of play include the utilization of complex symbols and engagement in social interactions. This, in turn, shows how autistic children may struggle to collaborate with their peers due to a lack of play skills [17]. Most children rapidly learn how to play with others, but autistic children, who often have difficulties in developing and adapting social awareness skills, may find it more challenging to establish lasting friendships. Those who have trouble approaching their peers may require further guidance on establishing a conversation or engaging in play with them [18]. This study aims to investigate the literature on collaborative play in the realm of autism.

Collaborative technology is often misunderstood and poorly defined, according to a recent systematic review of the literature on the subject of children with special needs [19]. Dispersed criteria based on collaboration and social skills have been devised to evaluate whether or not technological tools promote certain forms of social competence and engagement [19]. Large-screen TVs and interactive touch-enabled tabletop computers facilitate localized cooperative gaming (co-located games) [20]. Co-located games have several positive effects on autistic children, including increasing opportunities for social interaction and developing positive character characteristics like cooperation and teamwork [14,21]. Co-located and more traditional games, such as hide-and-seek or card games, are two examples of how autistic children might engage in collaborative play.

This study reviews fourteen papers on collaborative play among autistic children. The target age range for this study is 3 to 12 years old. Preschoolers are those between the ages of (3–5), and grade-schoolers are those between the ages of (5–12) according to the American Academy of Pediatrics [22]. Children are defined as those between the ages of 4 and 12 by the National Health Service (N.H.S.). [23]. This study aims to explore how autistic children engage in collaborative play and how their surroundings affect such activities. In addition, it is essential to establish collaborative play's primary elements and influences on autistic children and whether it occurs in inclusive settings. The following are the research questions that will be addressed in this review.

RQ1: What is the purpose of collaborative play, and in which context is it discussed?

RQ2: How is collaborative play employed in autism research?

This paper uses the results of a systematic literature review (SLR) to answer the research questions. This review aims to demonstrate the significance of play in the development of autistic children, especially collaborative play. In addition to encouraging play, it promotes peer collaboration among autistic children. The literature study shows that collaborative play between autistic children and their peers, as opposed to robots or adults, is still reasonably prevalent. However, most of the studies from 1967 to 2012 show that collaborative play involves adults or robots. However, this research aims to determine whether and how autistic children engage in collaborative play with their peers. This can be used as a method of peer intervention to help the children develop social and communication skills through play. Positive outcomes were seen following the implementation of the studied interventions. However, research indicates that no comprehensive literature review currently summarizes findings from studies on peer-to-peer collaboration among autistic children. Finally, the paper is structured as follows: By detailing the research methods, presenting the findings, and then discussing and concluding what was discovered in the paper.

2. Background

Fundamental definitions are presented in this section, emphasizing

how researchers have conceptualized and studied play, social play, and collaborative play. In addition, it explains how researchers are examining these many ideas in the context of autism. This part will also talk about how collaboration can be used to help autistic children improve their social and play skills.

It is important to assert that this literature review focuses on the studies in the field of Human-Computer Interaction (HCI). The field aims to comprehend and design technology usable by all users, including those with disabilities. This literature review aims to understand the potential of technology to support the inclusion of autistic children in play. This literature review explores the design and development of technology-based interventions for individuals with autism with the goal of contributing to the advancement of HCI research and the development of accessible and usable technology for all.

2.1. Autism

The American Psychiatric Association [24] states that symptoms typically appear between 12 and 24 months during the child's second year. Still, they may show up sooner or later depending on how well the child is growing up. At two, children begin to receive social cues and respond to societal stimuli provided by peers in various social settings. Autistic children may have trouble initiating or reacting to social contacts, integrating verbal and non-verbal communication patterns, and developing, maintaining, and comprehending relationships due to socio-emotional deficiencies. Therefore, providing resources and therapies that enhance social interaction and communication is crucial. Autistic children may have difficulty learning, especially when interacting with peers [24].

2.2. Play

A child cannot flourish without engaging in play, a skill they develop at birth [25]. Humans acquire knowledge of the world through action and interaction with others. Play primarily enhances one's abilities and capacity to conduct effectively in the real world. "Play" is primarily motivated by the desire to have fun and enjoy free time. It is related to a sense of freedom that individuals feel deeply. This form of freedom, neither disorganized nor indolent, is also recognizable by individuals who observe others playing. Play is a common way for children to show how they feel about being an active part of their environment and how motivated they are by their internal drives [26]. Children spend most of their time playing, which gives them plenty of chances to act on their irrational urges and uncontrollable wants [27]. The significance of play in children's development has been the subject of numerous theoretical frameworks. The modern historical theory of play known as *Homo Ludens* argues that children need to play because it helps them feel independent and satisfied, both of which are essential for their growth [28].

Play can also serve as an early intervention strategy to promote social engagement in autistic children. According to Morrier and Zeigler [29] the implementation of an organized and collaborative playing curriculum, known as the Buddy Game, led to a substantial increase in social overtures from autistic children toward their neurotypical peers during outdoor play activities. The Buddy Game intervention utilized familiar songs, physical activities, and interactive play during a 15-minute daily outdoor play. The approach appears to be an effective means to foster social interaction with peers.

2.3. Guided play

Competing trends in early childhood education emphasize the need for strong curricular approaches and unfettered exploration. A proposal was approached by Weisberg [30] for early learning to avoid this false dichotomy: guided play. Guided play takes advantage of children's natural abilities to learn through play by allowing them to express their

autonomy within a prepared environment and with adult scaffolding. Examples of how guided play situations have been implemented in past work, as well as evidence that guided play is successful for education across a range of content—even more successful than other pedagogical [30]. Play benefits the cognitive approach because it is a necessary aspect of children’s development and directly relates to cognitive and language abilities [31]. Bondiolo and Frawley [32,33] both argue that children benefit by regulating their more impulsive and emotional impulses, and both authors analyze the data in favor of this claim. Play is an essential factor in children’s language development because of the many cognitive and social factors it incorporates, which help children improve their communication abilities. Specifically, children benefit from guided play because it allows them to exercise their independence within a structured environment. It also takes advantage of children’s innate intelligence by enabling them to learn through playing with the help of adults [30]. Guided play is excellent for encouraging language development. Still, it requires close attention to the nature of the play and its outcomes. Weisberg [30] says, “The most important thing about the play is a rule that becomes a desire.” Players can get into trouble by following the rules, but the point of the game is to get out of these situations.

2.4. Types of play

The two fundamental dimensions of play development—cognitive and social—have been identified and classified by [26]. The cognitive dimension contains four types of play. The first type is practice play, an initial form of play that emerges in life and is associated with simple to sophisticated movements of the body and the exploration of things’ visual and tactile properties. Repeated behavior is characteristic of this play. In addition, there is symbolic play, which refers to the metaphorical use of one’s own body and objects, as if they were something else, to engage in pretend and make-believe activities. It begins around the second year of life. Acting out actions with your body, such as simulating eating, driving a car, and so forth, is the most basic form of this type of play. Role-playing involves acting out parts and creating situations for them. As for constructive play consists of assembling, fusing, organizing, and fitting together more pieces into a cohesive whole to achieve a specific goal. The child integrates skills acquired through repetition and symbolic play; the three types of play coexist and reinforce each other. The final method is Play with Rules, which involves activities and games based on a set of norms and guidelines. This process begins with basic rules that participants create to make their play activities more challenging, and it can progress to the use of board games and sports activities[26].

Among the social dimensions is solitary play, where the child is playing alone despite there being other children around them. Second is parallel play; the child engages in play separately from other people who are also playing simultaneously. The third type of play is associative Play; Although the child engages in a different activity than their peers, there is still a great deal of sharing, lending, and taking turns. Finally, collaborative play involves others in continuous play with toys, games, or other objects with a common objective or purpose. Children can differentiate between roles and plan cooperative games with a common goal [26].

As a result of the two fundamental dimensions previously discussed, each type of play manifests itself in a child’s life at a particular stage. Behavior is characterized by developing distinct behaviors that become more complex over time. Additionally, each form of play quickly combines with the others that are already part of the child’s repertory, causing modifications in them; conversely, in some instances, highly fundamental patterns of primitive types of play may reappear to support more advanced play activities [26].

2.5. Autistic children and play

Autistic children often struggle to develop social skills because they cannot engage in imaginative play [15]. Autistic children have been found to have difficulties with play, especially creative forms of play [34]. It has been discovered that autistic children do not differentiate their pretend play from the real world (for example, using a block to represent a car) or cooperate with another person to create the action [35,36]. Pretend play is a common way for children to learn about and experiment with social roles and rules and to grow in their understanding of the value of others’ perspectives [37,38]. Autistic children’s play is not as free-flowing and complex as that of typically developing children because they always try to replicate the social interactions and routines they witness. Children with cognitive problems may face obstacles when building their language, social, and creative skills. They rarely play with their peers and focus instead on playing with younger children [1].

2.6. Social play

To engage in social play, a child must be inspired by and interact with other children. When children play in this way, it shows they have the emotional regulation and social abilities essential to initiate meaningful interactions with others [39]. It is a highly efficient method of fostering psychosocial growth since it involves the coordinated participation of many individuals. It encourages children to conform to the behavior of their peers. Furthermore, it makes children aware of various viewpoints they can later agree with. It promotes the growth of comprehensive understanding, ethics, and relationships. Playing together fosters communication and friendship [40]. Children’s psychological growth and readiness for school are strongly correlated with their engagement in social play, which necessitates using cognitive and communicative skills [39,41].

Children can effectively start and respond to social stimuli supplied by peers during social contact in various social contexts. Three types of social interaction behaviors were identified by Brady et al. [42]: social initiation, social reaction, and externalization [43]. Children engage in social initiation by initiating a new social sequence, either verbally or nonverbally. It also differs from a continuation of a previous structure. The child’s behavior is a social response to a social trigger set by their peers and may be verbal or nonverbal. Externalization: It is important to note that the overt behavior was not directed exclusively at the play partner. This is an important behavior since it could provide a basis for continuing a social exchange with the partner.

2.7. Collaborative play

To build and keep a shared understanding of a problem, collaboration is characterized by Roschelle and Teasley as “a coordinated, synchronous activity” [44]. Using this approach, collaboration entails taking measures to reach a shared understanding of a problem (e.g., the challenges presented by a game). Collaborative player interactions are characterized as simultaneous activities in which two or more players coordinate their actions to accomplish a common goal [45]. These exchanges could involve several other minor techniques including role-playing, turn-taking, empathy, altruistic behavior, and others. In the literature, collaborative play can be defined in several ways (e.g., [46,47]). The diverse interpretations of collaborative play are directly tied to children’s socioemotional development. Understanding and engaging in collaborative play can significantly impact a child’s ability to develop social skills, foster empathy, and enhance their emotional intelligence. This type of play can serve as a crucial means for children to navigate and learn about various aspects of human interaction and emotion. This paper defines collaborative play as any self-generated activity shared by two or more children who have a common desire to continue and improve the play and a shared awareness of its purpose

and goal. play is essential for a child's development as it provides some revolutionary, practical benefits to the child's growth.

Social development is hindered in autistic children because they often face challenges in engaging in imaginative play due to the disorder's symptoms. Autistic children often struggle with role-playing games where their play skills are reduced, particularly in imaginative play, which is connected with autism [48]. When children play, or pretend, they do not differentiate the play from the actual event, substitute things for real props (such as a block for a car), or interact with another person in the development of the action [35,36].

2.8. Motivation

The motivation of this paper is that while typical kids can pick up new abilities through playing with others, autistic children face a variety of persistent difficulties with play development. The concept of play would overlook the fact that autistic children engage in any kind of play behavior [49].

Lack of pretend or imitational play is one of the features of autism throughout the early stages of development. Social interaction difficulties are another defining trait of autism that is essential to a diagnosis. Autistic children may struggle to participate in routine play because of social challenges[50]. They often find it challenging to communicate, react to social cues, and build relationships with others. [51]. Thus, this study will examine collaborative play that autistic children engage in, its dynamics, and how technology impacts it.

3. Methods

The purpose of this paper is to present the current state-of-the-art in the field of HCI on collaborative play for autistic children. As a result of combining research from numerous HCI proceedings with a multidisciplinary approach, four bibliographic digital library databases were explored relevant to the review [A.C.M., I.E.E.E., Scopus, and Google Scholar. It is essential to emphasize that this study is exclusively categorized as a SLR and does not incorporate any form of *meta-analysis*. Instead, the approach taken is qualitative, aiming to thoroughly evaluate and summarize relevant studies in a comprehensive narrative manner.

3.1. Process of systematic literature review

The SLR was conducted in four steps [52]. Data gathering involved database searches, identifying relevant articles, and extracting entire documents as the first step—the second and third steps required complete elimination. As a second step, they were restricted to articles that exclusively addressed disabilities other than autism. After removing irrelevant papers, the third elimination aimed to extract all publications that discuss individual play and play with non-children. As a final step, the full texts of the chosen papers were read, and essential data were extracted. The first author carried out three steps of removal and analysis.

This section extensively describes how data was collected and performed the SLR in the chosen database. This included: searching with the selected keywords in the (4) bibliographic database, finding publications, noting which ones to find, establishing inclusion and exclusion criteria to ensure thorough weeding, and examining the papers.

3.2. Data collection

The categories of children were first defined to analyze the research recruitment goal. Only autistic children were designated as the study's primary aim. In contrast, the children who constitute the target audience for actors are their ordinary peers. Individuals who participated in the collaborative practice using the digital tool, platform, or activity environment shared with the children, including their parents, teachers, and

others, were excluded. Multiple studies have identified virtual peers and robots as additional companion actors for collaboration, although they have also been excluded from the study. A total of two groups of users were examined: preschoolers (ages 3–5) and grade schoolers (5–12). The search of bibliographic databases was (A.C.M., I.E.E.E., Scopus, and Google Scholar). Afterward, the criteria for inclusion and exclusion and the search string and keywords were developed shown in Table 1.

3.3. Inclusion and exclusion

Following the initial search query, the following inclusion and exclusion criteria were used to filter out the papers:

- All publications from the four bibliographic databases were retrieved in September 2022. The earliest article was published in 1967.
- No books, notes, or reviews were included.
- Dissertations (such as doctoral consortiums), methodological papers, special interest groups (SIGs) meetings, demonstrations, and workshop calls were not included. Only empirical studies and peer-reviewed full papers in the four databases were included.

3.4. Additional notes on exclusions included

- Papers that do not directly target or involve children between the ages of 0 and 10 (for instance, if the students are university students or if the technology was not developed or designed with children in mind).
- Papers do not directly involve children in the collaborative engagement process (for example, if collaboration only occurs between adults).
- Papers that do not target or involve autistic children (such as those who deal with conditions that affect their level of development or a type of latency, such as learning difficulties).

In the study, 12 % of the total papers, amounting to 294, were selected for analysis, and this subset was evaluated by two independent raters. Remarkably, 267 out of these 294 papers were assessed as requiring exclusion by both raters. Subsequently, the remaining 27 papers, which were the subject of disagreement, underwent further. Each of the raters independently included 18 of these contested papers, resulting in a consensus on these selections. To measure the inter-rater reliability and agreement, the Cohen's Kappa test was employed, yielding a result of 98 %. This indicates substantial agreement between the two reviewers regarding study inclusion. This robust level of agreement between the raters underscores the reliability of the paper selection process in the study.

3.5. PRISMA

There were 2716 papers left after the first round of elimination. In this study, PRISMA was employed, which is an evidence-based minimum set of items for systematic reviews and *meta-analyses*. PRISMA focuses primarily on clearly and consistently presenting findings across the various bibliographic databases. [53]. Figure 1 shows the paper section flow. The purpose of this study is to exclusively utilize SLR methodology, without using any *meta-analysis* techniques as main

Table 1
Search String.

Database	Search String
A.C.M. Digital Library	((“Children“ OR “Child“ OR “Children”) AND (“Autis*“ OR “Autism Spectrum Disorder“ OR “A.S.D.”) AND (“Collaborative Play“ OR “Cooperative play“ OR “Collective play“ OR “Social Play”) AND (“Design“ OR “User“ OR “Study“ OR “Evaluation“ OR “Assessment”))
IEEE	
Scopus	
Google Scholar	

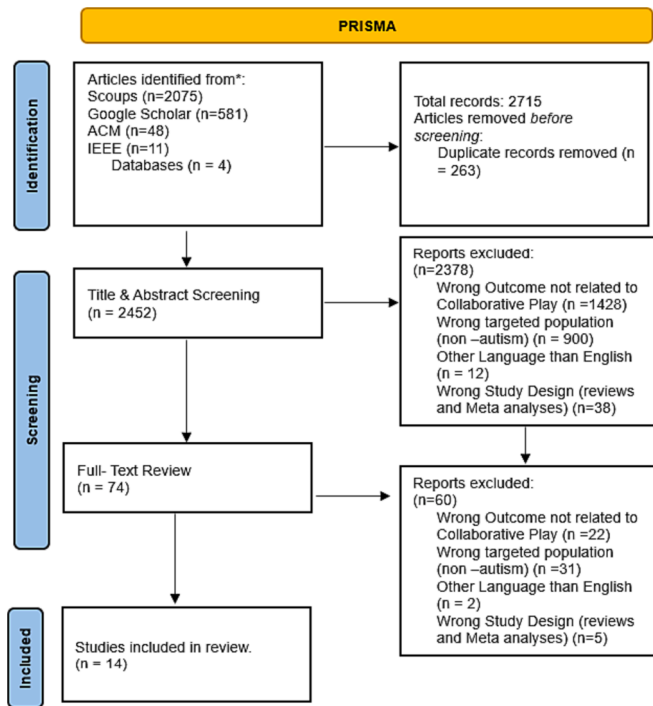


Fig. 1. Paper selection flow.

objective is to methodically gather, assess, and integrate the existing literature on collaborative play specifically tailored for autistic children, without employing statistical aggregation of findings across several research with an ultimate aim to provide a qualitative, narrative synthesis of findings from the included studies. In total, 74 articles were included after the title and abstract were scanned and were left with 14 articles after reading the full text. To ensure an objective selection of the papers, the two reviewers examined them together. All papers addressing collaborative play for Autistic children were included. In the subsequent phase, they focused exclusively on papers that dealt with or involved autistic children. The results of the papers that discussed collaboration with robots, collaboration with teachers, and collaboration with parents were categorized as “wrong outcomes.” Results targeting children who did not have autism were classified under the “wrong population” category. Those papers that included non-empirical results, such as reviews and theses, were excluded under the “wrong study design” category.

3.6. Data extraction

Quantitative and qualitative data were collected from publications for a database. Each sub-study’s qualitative analysis revealed the following details: the distribution of papers per year, country, and journal, children (age and purpose of recruitment) and actors involved in the collaborative practice, the context (e.g., school, museum, home, university lab, online platform, etc.), the type of collaborative technology, the overall aim of the study (i.e., gathering requirements, design, evaluation, or introducing a model), and the sorts of variables, if any, utilized for evaluating collaboration and whether a deductive, inductive, or mixed method was used, the research methodologies used in the study, and the forms of collaborative practices (such as tasks, activities, experiences). In the Results section, this is discussed in greater detail.

4. Results

The SLR’s results section focuses on the main findings of the 14 studies, including country, number of papers published, age, tools used,

procedure, and location. This gives insights into the distribution of research activities across different world regions. According to the findings, developed countries have a high concentration of published papers, with the highest number of studies conducted in the U.S.A. The review revealed that a significant portion of studies focused on ages 5–12 years, while the methods used in the studies varied greatly, including both qualitative and quantitative data. In addition, the study procedures varied from cross-sectional surveys to experimental interventions. Most studies were conducted in classroom settings, with a small proportion in the community or home settings. The findings of this study are valuable to future researchers in terms of identifying areas for improvement concerning geographical distribution and the need to conduct more research on underrepresented age groups and settings.

Research methods, study design, data analysis, and targeted skills are used to provide a comprehensive overview of the current state of research in this field. According to the study’s findings, the severity of autism is only mentioned in one study. Even though some studies used ten different study designs, the primary study design was a randomized control study. The data analysis methods employed were five listed below, focusing on descriptive statistics, and many of the studies focused on social skills, communication skills, and play skills. These findings must be incorporated into future research. They highlight the need for a more standardized approach and the development of more targeted interventions to address the specific skills and needs of individuals with autistic children.

4.1. Overview of included papers

Fourteen relevant papers were found between the years 2008 and 2022. In 2021, there has been an increase in the number of publications on collaborative play for autistic children (see Fig. 2). Between 2012 and 2021, only eleven papers were published, out of a total of fourteen. To the best of my knowledge, no papers matching the selection criteria were published between 1967 and 2007.

The geographical locations of the included studies were determined with details on the country wherein the study was conducted. If that information was unavailable, the authors’ affiliations and the funding source were utilized to ascertain the location. The majority of studies (5) were conducted in the United States [14,29,54,55,56] Three studies were conducted in the U.K. [57,58,59] (see Fig. 3). The remaining six studies were conducted in Australia (2), Iceland (1), Greece (1), Spain (1), and Belgium (1).

Based on the distribution across several databases (Table 2), the search query included the term “children,” and the search terms “collaboration” and “autism” were used. Most of the papers appeared in the *Journal of Autism and Developmental Disorders* (4), followed by the *C. H.I. Conference on Human Factors in Computing Systems* (2), *International Conference on Human-Computer Interaction* (1), *The Journal of Developmental and Physical Disabilities* (1), *Journal of Research in Special Educational Needs* (1), *A.C.M. Transactions on Accessible Computing* (1), *International Journal of Early Childhood* (1), *Journal of Applied Behavior Analysis* (1) and finally *PLOS one* journal (1).

Table 3 demonstrates the age groups studied in each of the thirteen publications. Children aged 5–12 were the most often researched, with children aged 8–11 being the oldest-reviewed population subset. Studies examining children aged 15 and older were excluded, as were babies aged 0–2. Approximately one-third of the studies (4 in total) included children between the ages of 5 and 12. One article [60] did not mention age, instead describing their population as children in primary school.

All included studies were required to meet two criteria: children between the ages of 2 and 12 years old must be included in the study, and the children must be diagnosed with autism. All studies featured autistic children. One study [60] included Autistic children and their siblings, and five studies included both Autistic children as well as those without. The remaining nine study participants population consisted of autistic children, among each other.

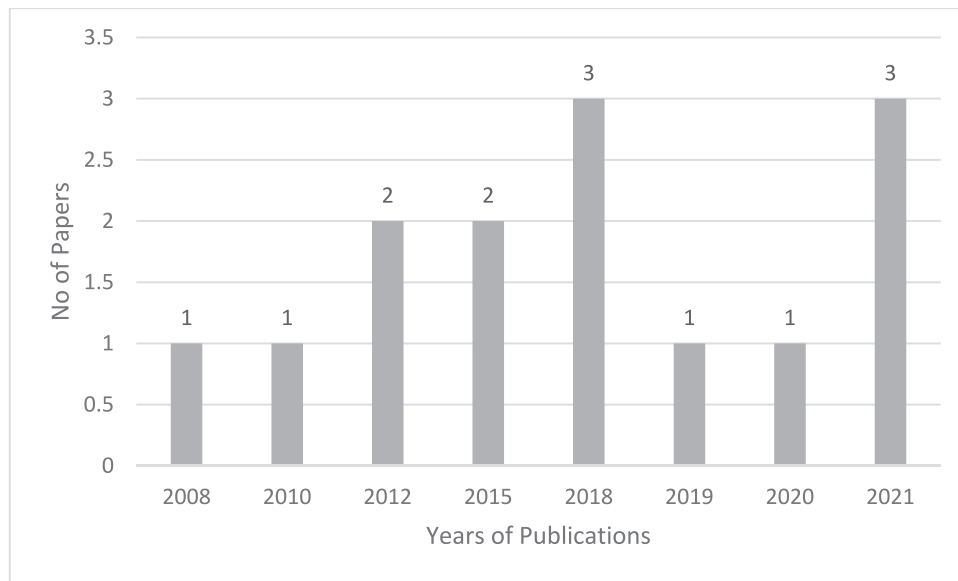


Fig. 2. Papers Published Per Year.



Fig. 3. Distribution of Included Papers in Countries.

Table 2
The distribution across several databases.

Bibliography Name	#	Ref.
A.C.M.	2	[14,58]
IEEE	0	
Scopus	6	[43,56,57,59,60,61]
Google Scholar	6	[62,63,54,64,29,55]

Table 3
Age Range in The Studies.

Age	Label	#	Ref
3–5 yrs.	Preschool	6	[29,56,57,59,62,64]
5–12 yrs.	Grade-schooler	7	[14,43,54,55,58,61,63]

Most studies required a mediator, teacher, or specialist to facilitate social and collaborative interactions and play between autistic children. Only one paper [63] shows that the study population included autistic children and their peers.

4.2. A.S.D. severity in children

Only one out of the 14 articles discussed the severity range in autistic participants. Gali – Perez [43] mentioned the degree of autism in the children who participated in the study. The study used the Autism Diagnostic Observation Schedule (ADOS) scale. They also used the Wechsler Intelligence Scale for Children (WISC-V), both with children with and without autism, and achieved a minimum I.Q. of 70.

4.3. The purpose of the studies

Table 4 provides an overview of various studies and the tools they employ to address different purposes related to autistic children and their engagement in collaborative play. These studies utilize a range of

Table 4
The Evaluation and the Purpose of the Studies.

Study	Tool	Purpose
[14]	Housed on off-the-shelf, low-cost platforms such as the iPad.	To facilitate social relationships in Autistic children through an empirical study of the use of a collaborative iPad game.
[29]	The buddy game intervention utilizes well-known songs, movements, and games.	This article highlights how Autistic children interact during structured outdoor play.
[43]	The present study uses mixed reality (M.R.).	To foster social interaction behaviors (S.I.B.s) in a child with autism and a play partner without autism.
[54]	Board games and playing games.	Evaluating the social and play skills of Autistic children
[55]	The Integrated Play Groups (IPG) model.	Support autistic children to participate with typical peers in mutually engaging experiences in natural settings and increase their social play skills.
[56]	Activity schedules.	To learn if Autistic children can engage in complex group play.
[57]	An augmented knight's castle (A. K.C.) play set was adapted.	To allow more collaborative play among children.
[58]	Mazi is an e-textile sonic TUI tool.	To support collaborative play in a group of Autistic children;
[59]	Evaluating the strategies of play adopted by the teachers of a child with autism.	Through collaborative play to facilitate her inclusion and Play skills by interacting with her peers (collaborative play)
[60]	This study used naturalistic observational methodology.	Encourage collaborative play in a familiar context.
[61]	Free play sessions.	Evaluating the nature of play activities and the social engagement of Autistic children in an inclusive early childhood setting.
[62]	Lego WeDo 2.0 is employed in this study for an educational robotics intervention.	Engaging Autistic children in collaborative play.
[63]	Play-based therapy is a play-based intervention.	Focusing on cooperative play, communication, and problem-solving
[64]	Portable video modeling.	To evaluate the effects of video modeling on the social skills of Autistic children.

innovative methods and interventions, from mixed reality and educational robotics to board games and e-textile tools, all with the shared goal of fostering collaborative play and improving social skills in Autistic children. Each study's unique tool and purpose contribute to the understanding of how to facilitate inclusive play experiences and enhance the lives of these children.

All fourteen studies explained the purpose of their study and their aim to foster collaborative play. Depending on whether a technological or traditional tool is used, each study evaluated collaborative play differently. Table 4 summarizes the purpose and evaluation of each study to foster collaborative and social play among autistic children.

4.4. Research methods and data collection methods

This review categorizes the primary studies' research designs into three groups based on their research methods: quantitative, qualitative, or mixed-method approach. A total of eight studies are quantitative [29,43,54,55,60,61,63,64], five use a mixed-method design [14,56,57,58,62], and one study used a qualitative design [59].

Quantitative data was collected through questions to generate statistical methods, and qualitative data was gathered through interviews. These interviews were audio-recorded and transcribed for detailed analysis alongside observational data. Mixed-method data studies utilized field observations and video recordings in conjunction with interviews and voice notes. Examples of quantitative data such as Mean and standard deviations for each dependent variable and the statistical analysis software SPSS [62]. Refer to Table 5.

Table 5
Data Collection Methods.

Research Methods	Total
Quantitative.	8
Mixed Method Design.	5
Qualitative.	1

4.5. Study design

The selected studies have been organized into ten categories based on the research design described. These include Pre-and Post-Tests, Randomized Controlled Trials, Multiple Probe Designs, Baselines, Within-Subjects, Between and Within Subjects, Between Subjects, Quasi-Controlled Designs, and User-Centered Designs.

The Randomized Control trial was most frequently used across the fourteen studies, with three utilizing this particular method [29,56,63]. Two studies used Within-subjects [43,61]. The remaining nine studies used the following: Sociometric [62], Multiple Probe Design [54]; Baseline [64]; Between and Within Subjects [60]; Between Subjects [57]; Quasi Controlled [14]; User-Centered design [58]; Baseline and Pre-and Post-tests [55]; Pre-and Post-Tests [59].

4.6. Data analysis

Ranganathan & Aggarwal [65] described five primary categories of data analysis: 1) Descriptive Analysis, which describes the study results; 2) diagnostic analysis, which investigates the causes of a certain phenomenon; 3) Predictive analysis, which states if a certain phenomenon will occur in the future or not.; 4) prescriptive analysis, which shows the most advantageous course of action presented.; 5) A combination of inductive and deductive thematic analysis approaches. The inductive approach involves allowing the data to suggest the themes. The deductive method involves approaching the data with some prior assumptions regarding the themes anticipated being represented based on a theory or previously held beliefs [66]. According to the results, five studies employed descriptive analysis, five used prescriptive analysis, and four used a mix of inductive and deductive thematic analysis.

4.7. Tools used and procedure

There was a strong emphasis on collaborative play throughout all the papers included. Six out of fourteen papers [14,43,57,58,62,64] utilized technological tools to encourage collaborative play between autistic children. For instance, a Mixed Reality Approach [43] was developed to promote social initiation among autistic children and children without autism of comparable ages and genders.

Eight papers [29,54,55,56,59,60,61,63] utilized traditional tools, such as playing hide-and-seek with autistic children among each other. All fourteen studies discussed familiarizing children with the procedure. As a result, it can be concluded that familiarizing children with what they have to do will make them more comfortable and familiar with what they are doing and more likely to engage in the activity.

4.8. Study location

The studies were conducted in three setting categories: school environment, community environment (social groups), and home environment. The most frequent setting was a school environment such as a classroom, which was employed in eleven [14,29,43,54,55,58,59,61,62,63,64]. Three studies utilized a community space to introduce a social skills group for children with A.S.D. one controlled study environment was a 4mx2 room [57], 4mx2 usually reserved for computer work. The second environment was created through observation during a short play in a familiar context (Grandma's house or the child's house) [60]. One of the classroom

environments was an outdoor playground [56]. No studies failed to mention the environment or setting.

4.9. Play types and targeted skills

All studies focus on building various skills, including three types of skills: Social Skills [14,29,43,54,60,62,64]; Play Skills [59,63]; and Social and Play Skills [55,56,57,58,61]. The studies examined two types of play: Structured Play and Unstructured or Free Play. The definition of active play, also known as unstructured play, is “a type of gross motor activity that children engage in freely, in the form of fun and without restriction” [67]. In contrast, structured movement sessions are defined as “deliberate practice that is planned and designed with a specific goal of improving performance, (b) requiring cognitive and physical effort, and (c) relevant to promoting the development of positive skills” [68]. Twelve studies have looked at the structured play, while the other two explored unstructured Play [29,60]. The unstructured play method was used to foster social skills. Structured play was utilized for several reasons, including fostering social interaction [14,43,62], social and play skills [55,56,57,61], and play skill [59,63], and learning games [54].

5. Discussion

This review explores research in the field of collaborative play for Autistic children. 2697 articles were initially considered by Google Scholar, Scopus, IEEE, and ACM Digital Library, and only fourteen papers were found relevant to the topic and included in this systematic review.

While criteria were set to review studies published between 1967 and September 2022, no articles written before 2008 were found that met research criteria for autistic children with only a cooperative play environment. Any papers excluded before this time usually included autistic children and other conditions not included in the inclusion requirements criteria. Thus, papers published between 2008 and 2022 were included. Further, collaborative play for autistic children has gained increasing interest worldwide, and most studies have subsequently been conducted in the United Kingdom, the United States, and Australia. There has been an increase in interest among HCI researchers in this area.

The following research questions have been considered:

RQ1: What is the purpose of collaborative play, and in which context is it discussed?

RQ2: How is collaborative play employed in the autism research process?

5.1. Autistic children and skills targeted in the studies

Five studies [55,56,57,58,61] used technological intervention to foster social and play skills in autistic children. They agree that digital technology provides a critical support system for those with autism (e.g., [69]). Using technology, autistic children can improve their logical memory, voluntary attention, and goal-directed behavior through compensatory mechanisms [33]. By providing autistic children with the opportunity to interact with others and form relationships with their peers, technology can contribute to the development of their social skills [70]. Based on the compelling evidence from these studies, it becomes abundantly clear that technology holds a pivotal role in interventions aimed at enriching the lives of autistic children. Its capacity to enhance a spectrum of skills, alongside its role in facilitating social development, positions it as a highly valuable resource with the potential to yield significantly improved outcomes for these individuals. Consequently, the exploration and integration of technological interventions into programs designed to support the social skills of autistic children represents a crucial avenue for further research and development.

In the rapidly advancing landscape of technology, including but not limited to virtual and augmented reality, tangible interfaces, and other

emerging innovations, there exists a vast potential for substantial progress in this domain. This dynamic sphere presents both a fertile ground for innovation and a pressing gap that demands attention. By harnessing the capabilities of technology, we can not only empower autistic children to develop essential skills but also bridge the gap in support and opportunities, ultimately fostering greater inclusion and well-being.

5.2. Tools used

The studies incorporated a variety of tools that encompassed both technological and non-technology components, that aim to support collaborative play. The research highlights the significant impact of technology in augmenting collaborative play experiences for autistic children and their neurotypical counterparts. As demonstrated by work employing Topobo, it is a 3D constructive assembly system with kinetic memory that was first introduced by R. Inman et al. in 2006 [45]. It is designed to allow users to build and manipulate 3D structures with the added ability to record and playback physical motion. The system is comprised of modular blocks that can be snapped together to create various shapes and configurations [71]. A tactile interface for autistic children may also encourage co-located cooperative work [57]. Through this straightforward functionality, children can observe cause and effect, which is both motivating and assists in reinforcing attention to objects. autistic children may benefit from the multiple entry points, both data-driven and socially oriented. [72]. This article [57] explains how social interaction among autistic children can be facilitated by collaborative assistive technologies running on readily available, affordable platforms like the iPad. They investigated how assistive technology can be utilized to foster social relationships even without adult intervention through an empirical study of the use of the cooperative iPad game Zody, short for Zody's World: The Clock Catastrophe3, which is a collaborative iPad game developed by SymPlay. In accordance with SymPlay's website, each game features a cooperative mode that demonstrates the benefits of working with others and paying attention to their actions. The overall goal of the game is to collect several pieces in order to reassemble a clock that has been stolen at the start of the game. Participants had to be physically close to one another because of the iPad's small size, and having a role for both players promoted participation and all technological methods employed achieved a satisfactory rate of collaboration among autistic children.

Additionally, eight studies implemented the use of traditional scenarios [29,54,55,56,59,60,61,63] such as playing hide and seek and LEGO mentioned in the studies enable cooperation to achieve other objectives, including learning and training, entertainment and informal communication, and task completion. Ultimately, teamwork is crucial for all autistic children so that they can initiate collaboration.

The remaining studies that did not utilize technology interventions [63] cited peer-mediated interventions (PMIs) as a successful intervention strategy for improving essential social communication and social interaction deficits in autistic children. Sessions are held once a week in a clinic setting, and parents facilitate weekly home playdates between the dyad with the help of a parent education manual and DVD. The Ultimate Guide to Play, Language, and Friendship (P.L.F.) effectively enhances play behavior in autistic children with spectrum disorders [63]. The P.L.F. is a sophisticated intervention that takes place over a 10-week period and integrates therapist, peer, and video modeling in a play-based setting. Once a week, sessions are conducted in a clinic. With the help of a parent education manual and DVD, parents organize weekly playdates between the dyads at their homes. The P.L.F. has been modified to accommodate autistic children aged 6 to 11 years of age. As a result, the P.L.F. effectively raised peers' play performance and improved their social abilities.

The findings from the studies have significant implications for both research and practice in the realm of interventions for autistic children. The incorporation of a diverse range of tools, including both

technological and non-technological components, to support collaborative play underscores the pivotal role of technology in enhancing collaborative play experiences for autistic children and their neurotypical peers. It is evident that embracing diverse intervention strategies, including technology-driven approaches, traditional scenarios, and peer-mediated interventions, can have promising results when addressing the complex needs of autistic children in addition to promoting their social development and collaborative skills. Further research and innovation in these areas hold the potential to significantly enhance the quality of life and social inclusion of autistic children.

5.3. Procedures in the studies

Morrier & Ziegler [29] conducted a study wherein 35 toddlers and preschoolers with and without autism participated in the Buddy Game, a 15-minute outdoor play program. Using well-known songs, movements, and activities promotes peer social engagement. In accordance with research [73], peer buddies, or autistic children paired with trained peers, can assist kindergarteners with autism in developing adequate social skills. This study sought to determine the effectiveness of activity schedules with embedded scripts for teaching three autistic children to play challenging social games.

It is shown by Akers et al [56] that autistic children were specifically taught to play hide-and-seek with their friends who were typically developing. As a result of the introduction of activity schedules, participants began to play hide-and-seek independently. The study participants were carefully selected because the target children possessed certain qualities, including (a) the necessary abilities (i.e., vocal conduct, following an activity schedule), b) showing some interest in their classmates, and (c) they did not exhibit a lot of problem behaviors, making it easier for the children to grasp the game and skills. This article [56] also discussed how autistic children have difficulty socializing with peers of their own age during unstructured play environments (e.g., in playgrounds).

Finally, a unique study [60] included both autistic children as well as their autistic siblings. It is well known that sibling relationships are crucial for a child's early development. However, studies on very young children whose older siblings have autism are rare, so this study covers this topic. Using naturalistic observational methods, this study compared how autistic children interact with their siblings. There was a significantly higher degree of positive behavior among siblings with an older sister as a partner. It is imperative to consider these early relationships when developing future autism research and interventions, as variations in sibling interaction may significantly impact both siblings' developmental outcomes. A recent study [60] stated that most social interactions occur between children and their parents or caregivers during the early stages of development. Interactions between siblings are extensive, long-term partnerships that have a long-term impact on both siblings.

The findings provide valuable insights into the design and implementation of interventions for autistic children, emphasizing the importance of diverse approaches and early relationships in their developmental journey. This in turn emphasizes the need for tailored interventions that incorporate familiar elements, structured approaches, and an understanding of the children's relationships with others. These key elements are crucial to supporting the social development of autistic children effectively. Recognizing the multifaceted nature of social challenges and early relationships in their developmental journey can inform more holistic and impactful interventions and research efforts in the field of autism.

5.4. Inclusiveness in the studies

All studies stress the importance of participating meaningfully in all elements of an inclusive early childhood program that embraces and encourages diversity for autistic children who experience specific

challenges that limit their ability to communicate, interact socially, and comprehend the thoughts and feelings of others. These challenges have a significant impact on the quality of life of these children [74] and found that instructors' involvement facilitated complete inclusion, not just in terms of quantity but quality as well. They found that different types of adult-initiated involvement either inhibited or facilitated children's subsequent engagement with peers for both typically developing children and autistic children.

All fourteen studies encouraged inclusiveness, and each experiment initially included a teacher or specialist to guide the children. This was done to ensure that the children were familiar with the activity and could experiment before they began if needed. The studies agree that teachers must prioritize encouraging play as a means of communication and education to ensure inclusiveness. Vygotsky [27] was one of the first to explain that adults must facilitate play to enhance the learning process [57,61,75].

5.5. Importance of play in autistic children

Seach [75] describes how structuring children's play is a vital component of early childhood education, with debate raging about what form this should take. The teacher takes the role of both a supporter and a mediator. An ethnographic study of Vicky at Forest Nursery [59] described how instructors best facilitated autistic children's experiences. The case study demonstrated how a strong emphasis on inclusive play and a team-based strategy and curriculum framework could give instructors and students creative places to explore their interests without turning to specialized techniques. Through an active learning process, the community of adults and children at Forest Nursery took a proactive approach to learning about establishing reciprocity, shared meaning, and mutual enjoyment of inclusion in play.

In addition, [59] Theodore argues that to ensure inclusiveness, teachers should prioritize promoting play as a means of communication and education. Further, the focus on play should address both academic prowess and social inclusion. Play implies cognitive and mutual engagement, both of which are essential for friendship and social interaction. Therefore, adults should facilitate play to support learning and engagement. Occasionally, autistic children may not participate as expected in social interactions, struggling to attract other people's attention, or interacting in playful engagement.

The implications drawn from this section highlight the critical role of structured play in early childhood education, especially for autistic children, and underscore the importance of inclusive and team-based strategies in fostering their development. Structured play sessions, when approached inclusively and through a team-based strategy, can significantly benefit autistic children in early childhood education. Prioritizing play as a tool for communication and education, with a focus on both academic and social development, is essential for fostering a supportive and inclusive learning environment that encourages growth and engagement for all students, including those with autism.

5.6. Familiarizing

The findings also demonstrate that all fourteen articles agree that during unstructured play, autistic children experience challenges in socializing with peers their age (e.g., on the playground). Most studies were conducted in child-friendly environments such as classrooms and playgrounds to mitigate this issue. Most of the time, autistic children are encouraged to work together with peers (who may or may not have autism), but parents and teachers were instructed not to work or play directly with them. A surprising finding emerged, explaining that play and collaboration are often ambiguous or, more likely, do not exist. Based on the situation, play may be viewed as a subset of another higher-order talent or as an umbrella term encompassing various social skills, behaviors, and activities. According to the studies evaluated, play was frequently used interchangeably with other concepts (such as

cooperation, group skills, and social interaction). There was no consensus on what it meant other than in two studies [57,61].

5.7. Adult intervention in the studies

No consistent method of assessing or measuring play behavior and abilities without using mediators or interventions was identified. For many of the studies that evaluated or quantified collaboration, self-determined criteria were combined with those from a wide range of other frameworks [14,57,58,59,60,62,63]. Due to dispersed evaluation criteria, a lack of precise definitions, and the interchangeability of concepts, it is difficult to compare studies and accurately assess which technologies are most effective in increasing cooperative behavior and skills among autistic children.

As most studies relate to educational and therapeutic settings, this review is particularly pertinent for designing and evaluating collaborative technologies for autistic children. Educators, treatment providers, and researchers alike should therefore be encouraged to develop and validate theoretical frameworks and tools. In most cases, qualitative and quantitative data were utilized in the studies. Based on the findings of this review, collaborative play tools for autistic children have gained more widespread popularity, but further research is still required. This review aims to serve as motivation for future research to specifically address new progress on the benefits of utilizing collaborative technology with autistic children.

5.8. Limitations

Only papers that addressed collaborative play with children among each other and not robots or adults were included in the review. The challenges and limitations of the study were data analysis problem-related [59], missing Data [43,59,63], and limited participants and timeframe [14,48,54,55,60].

Primary studies were categorized based on the following factors: research questions developed based on the study's objectives; keywords selected to identify primary studies; time frame for searching primary studies; type of venue; and inclusion and exclusion criteria. These characteristics may impact the feasibility of including papers for further consideration, which could be considered a limitation of this study's SLR. Additionally, the scope was limited to studies written in English and published on one of the four databases utilized, which impacted the scope of what was available to be perused.

Furthermore in the realm of computer science, conducting quality assessments is a widely acknowledged and practiced method, as supported by several scholarly references in the field [76]. It is crucial to recognize that not applying quality assessment is considered a limitation. Even though a Cohen's kappa inter-rater reliability test was undertaken with two independent raters resulting in a reported high percentage of agreement (98 %).

6. Conclusion

The findings of this comprehensive literature review study are expected to benefit educators, parents, and researchers by providing helpful insight and direction. This SLR considered articles published until September 2022. Four databases researched pertinent studies to provide insight into collaborative play solutions for autistic children. The authors have employed various collaborative play techniques with or without technological intervention. The researchers ensured that all studies were conducted in an inclusive and familiar setting with teachers and mediators without physical interference. The children were only told the rules before starting and were occasionally guided during the trials. Digital technology provides a critical support system for autistic children. The use of technology can support the development of social skills by mediating interactions and fostering peer relationships and teamwork. This systematic discusses how technologies running on

readily available, affordable platforms, such as the iPad, can facilitate social interaction among autistic children.

The studies offer valuable insights into how technology has enabled and enriched collaborative play experiences for autistic children during interactions with their peers. Consequently, emphasizing the importance of technology for autistic children and their peers becomes imperative. Several important advantages arise as children engage in cooperative play made possible by technological tools: Multi-user virtual and immersive environments allow autistic children to collaborate. These environments, which imitate real-world social situations, can encourage the child to collaborate. Virtual environments that simulate social interactions allow children to practice and develop their social and collaboration abilities in a secure and regulated environment. Moreover, incorporating directed, mutual, and parallel play into virtual worlds can enrich learning. Guided play by adults or peers helps the children comprehend and negotiate social interactions. Mutual play encourages teamwork and communication by having children work together. Parallel play helps children observe, imitate, and develop social awareness by doing comparable things. Additionally, the research review also emphasizes the importance of physical interactions with tangible and virtual objects in enriching play. Physical objects in virtual settings increase sensory and tactile play, making it more immersive and engaging. Exploring how design components improve social skills and collaborative play in the realm of autism is a gap yet to be addressed.

A peer-mediated intervention (PMI) effectively resolves fundamental social communication and social interaction deficiencies in autistic children. The Buddy Game [29] is another recommended intervention that utilizes well-known songs, movements, and activities to encourage peer social engagement. The manual encourages parents to organize weekly playdates in a clinic setting. Another study was conducted with 35 toddlers and preschoolers, both with and without autism. Participants successfully acted independently in hide-and-seek activities following the introduction of the activity schedules. Lastly, the interaction between siblings is an extensive and long-term relationship, which has a lasting impact on each sibling's growth. This may be partly because, in the early stages of development, interactions with caretakers and siblings constitute the majority of the social environment [60].

Autistic children experience specific challenges that affect their ability to communicate, interact socially, and comprehend the thoughts and feelings of others. These challenges can significantly impact the quality of life of these children. To ensure inclusivity and to aid autistic children in adjusting to the new environment, most studies were conducted in child-friendly places such as classrooms and playgrounds. Future researchers are encouraged to continue meeting children where they feel most comfortable providing the best care for study subjects. Additionally, it is recommended that teachers continue to emphasize the importance of play as a means of communication and education. An ethnographic study [59]; has demonstrated that a strong emphasis on inclusive play, a team-based strategy, and a curriculum framework can provide instructors and students with creative ways to explore their interests. autistic children may not engage in social interactions as expected, which may include struggling to attract the attention of others or displaying a lack of enthusiasm for play. To mitigate these challenges, a growing number of collaborative play tools are being developed for autistic children, as this review showed. However, more research is necessary in order to better understand collaborative play between these children and their peers through technology and without the intervention of a mediator.

CRediT authorship contribution statement

Shaza Khatab: Data curation, Formal analysis, Investigation, Methodology, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Mohamad Hassan Fadi Hijab:** Data curation, Methodology, Validation, Visualization, Writing – review & editing. **Achraf Othman:** Conceptualization, Funding acquisition,

Writing – review & editing. **Dena Al-Thani**: Conceptualization, Data curation, Funding acquisition, Methodology, Validation, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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