Effects of Physical Activities on Social Skills and Well-being in Autistic Children
A systematic literature review from 2012-2023

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ABSTRACT

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Background: Physical activity (PA) benefits people of all age groups. PA can improve not only physical fitness, but also social skills, behavior as well as psychological well-being in neurotypical populations. Social skills and well-being are essential elements for life. Autistic children face deficits in both these aspects. Since positive effects regarding social skills and well-being have been found in TD population, positive benefits following participation in PA may also be found in children with autism.

Aim: This systematic literature review aimed to identify how participation in PA affect social skills and well-being in autistic children.

Method: A literature search was performed in five databases to find peer-reviewed studies identifying effects of physical activities on social skills and well-being. Nine studies met the predefined selection criteria.

Results: Several types of physical activities improved various social skills and decrease challenging and adaptive behaviors in preschool and school aged autistic children. Promising findings were found regarding well-being aspects, relationships with peers and motor skills.

Conclusion: Physical activity can improve social skills, behavioral problems and adaptive behaviors in preschool and school aged autistic children while results on well-being, peer relationships and motor skills look promising.

Keywords: Physical activities, social skills, well-being, children, autism spectrum disorder

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1. Introduction

According to American Psychiatric Association (APA, 2013) deficits in social functioning, communication and social behavior are major symptoms in autistic people. Autistic children have also found to have lower levels of happiness (McChesney & Toseeb, 2018). Physical activity (PA) can help autistic people to “attenuate” difficulties in socialization and communication through participating in it (Hillier et al., 2011). Additionally, benefits regarding quality of life has also been found in autistic children after participation in PA (Toscano et al., 2018).

Autism is one of the two most common neurodevelopmental disorders that impact children (Centre for Disease Control and Prevention [CDC]; Scandurra, 2019). Terms utilized to describe autism vary depending on several factors. Identity-first language, where the disability is an intrinsic part of the person's identity is the term most commonly used now (Kenny et al., 2016).

PA is any form of body motion which requires energy cost (World Health Organization [WHO], 2022). The effectiveness of PA can be ensured by the complex interventions approach. According to Medical Research Council's (MRC) complex interventions are those that have “several interacting components”. The aim of the complex interventions approach is to increase the quality of interventions and their implementation, leading to greater outcomes (Craig et al., 2008). Autistic children have been found to have lower physical activity levels in comparison with neurotypical children (Jones et al., 2017) as they tend not to be taking part in organized activities such as sports (Memari et al., 2015). World Health Organization (WHO, 2007) defines participation as “involvement in a life situation”. For a child to be assumed that he/she participates in an activity, it requires both attending and involving in it (Imms et al., 2017).

Social interaction is required when participating in physical activity in several contexts, which is challenging for children with autism (Arnel et al., 2020). Social and behavioral difficulties work as barriers to their participation in any kind of structured and unstructured forms of physical activity (Must et al., 2015), many times leading to inactivity (Pan, 2009). Sedentary behaviors and no engagement in any kind of exercise can lead to short- and long-term health consequences (Jones et al., 2017).

Based on the knowledge of Daily Life Therapy’s (DLT) approach outcomes, individuals can enhance their daily functioning and quality of life by participating in daily activities (Quill et al., 1989). People in all age groups can benefit from taking part in sports or in regular exercises (Silva et al., 2020). PA is vital for children as it can help
them enhance not only their physical condition, but also their social skills, behavior as well as self-esteem (Strauss et al., 2001). Social behavior and communication skills of autistic children, necessary for peer interaction (Glick & Rose, 2012), might be enhanced through participation in exercise (Lourenço et al., 2015). Participating in PA might proffer opportunities for socialization with peers (Jones et al., 2017). Additionally, PA can enhance psychological well-being in this population (Pangrazi, 2003) by boosting happiness and self-esteem (Strauss et al., 2001).

Conducting a study focusing on the participation of preschool and school-age autistic children in PA is important. PA has proved to enhance social skills and well-being in neurotypical populations. Whether these effects apply to autistic children is not well known. To better support children who have difficulties in these domains, it is also important to examine what aspects of social skills and well-being can be affected by PA activities. Bronfenbrenner's bio-ecological model will be utilized to discuss these results (Bronfenbrenner & Morris, 1998).

2. Theoretical background
2.1 Social skills

Social skills are usually defined in relation to social competence and are considered as the necessary skills that allow successful social responding (Grover, 2020). Having great social skills leads to the expression of feelings, to reading someone’s emotional state, and to handle potential relationship issues by taking the perspective of other’s into consideration (Demir et al., 2012). Friendship can be defined as the most vital of all social relationships and is described as a stable, eternal and mutual relationship among two people that includes mutual fondness, preference and enjoyment (Webster & Carter, 2007). Friendship is usually determined as companionship by younger children whereas older ones describe it as self-revelation, attachment, and closeness with their peer (Rose & Asher, 2000). Social, cognitive, and emotional development, which impact a person’s general welfare, are encouraged positively by friendship (Hartup & Laursen, 1993). To create interpersonal relationships, a compound set of skills such as social cognition, language, and emotions are required. Neurotypical children usually obtain the skills needed for socialization easily through exposure to several social conditions. If felicitous peer relationships are not created in the early years, emotional and behavioral issues might occur as the involvement in peer interrelations during these years plays a crucial role to the evolution
of foundational skills for social relationships such as communication, emotional control, conflict resolution, and collaboration skills (Webster & Carter, 2007).

2.2 Social skills in autistic children

According to American Psychiatric Association (APA, 2013), deficits in social interaction and communication is evidence in autism diagnosis. Autistic individuals might have different social and communication styles than neurotypical people that may not be acknowledged or valued by mainstream society as the medicalization of autism has pathologized and marginalized this population (Silberman, 2015).

Autistic children face difficulties in creating relationships and friendships. A reason to this might be the fact that the process of conquering the necessary social interactional skills is demanding for the majority of them (Klinger et al., 2007). Both cognitive and emotional deficits impact social interactions (Twachtman-Cullen, 2000). More specifically, there is difficulty in comprehending and foretelling other people’s actions as well as deficits in social executive function skills requisite in social interaction. Central coherence is also weak, hence autistic children are better at seeing parts but not wholes, making it hard for them to contemplate other’s perspectives and to apprehend and comprehend social and emotional signals (Lord, 1990).

Another equally important reason for the difficulty in creating friendships can be described by the double empathy problem. Considering this, comprehending each other’s perspectives and experiences is not solely autistic children’s difficulty but rather a mutual difficulty for both autistic and non-autistic individuals (Milton, 2012).

According to the social model of disability, social difficulties experienced by autistic children are not only due to social cognitive impairments as an autism deficit but also due to inappropriate environments and social contexts that do not accommodate neurodiversity. Inclusive environments might help autistic children think and communicate in a way that is more natural to them and ultimately lead them to improve their social skills (the Social Model of Disability, 2013).

2.3 Well-being in autistic children

According to the Centers for Disease Control and Prevention [CDCP], the national public health agency of the United States, well-being is a state of experiencing positive emotions, feeling satisfaction and fulfillment in life as well as functioning consequently (CDCP, n.d.). A person’s emotional, psychological, and social well-being is their mental health (Centers for Disease Control and Prevention [CDCP], n.d.). Anxiety and depression symptoms can lead to poorer functioning in all domains of quality of life (Brenes, 2007). Autistic people and children have lower levels of quality
of life than TD people (van Heijst & Geurts, 2015; Zhen-Huan et al., 2016). They also have been found to have lower levels of self-esteem and happiness than not autistic children (McChesney & Toseeb, 2018). This can happen as everyday life is more challenging for them. Difficulties in comprehending social situations and relationships, being misapprehended or not accepted by others can lead to the development of anxiety, stress as well as depression (National Autistic Society, n.d.). What is more, autism is usually considered based on the traditional medical model, one that includes stereotypes and misconceptions instead of a more holistic approach that values the strengths and the contributions of this population. A more holistic approach will promote well-being in neurodiverse people (Silberman, 2015).

2.4 Physical activity in autistic children

According to article 30 of the Convention on the rights of persons with disabilities (CRPD, 2006) people with disabilities have the right to engage actively and equally with others in physical activities and sports. For that purpose, all states should allow their participation with the guarantee of non-discrimination, equal access and distribution of funding for inclusive and adaptive sports.

Impairments in social communication and interrelation with peers are evident in autistic children (Hortal-Quesada & Roberto Sanchis-Sanchis, 2022). Many studies support that the largest portion of autistic children face huge difficulties in creating friendships and peer relationships (Petrina et al, 2014). Physical activities have been found to boost social communication skills in autistic children and enhance the interrelation with peers. Additionally, challenging behaviors can be reduced through participation in them (Hortal-Quesada & Sanchis-Sanchis, 2022). Moreover, numerous studies have shown that autistic children can also profit from participation in physical activities as self-confidence and hence the feeling of happiness are enhanced (Strauss et al., 2001).

Motor skills and physical activity in children are interrelated components; children with better motor skills participate more in PA and participating in physical activity can improve motor skills (Barnett et al., 2016). A great number of autistic children do not have the age appropriate motor skills (Green et al., 2009; Hilton et al., 2012). They have various motor impairments compared to TD children (Crucitti et al., 2019). Motor impairments can lead this population to avoid taking part in activities with other peers, leading to reduced stimuli for social skills development (Bhat et al., 2011). Physical activities have been found to enhance the motor skills of autistic individuals (Hutzler & Margalit, 2009; Pan, 2011).
2.5 Bronfenbrenner’s bio-ecological model

Bronfenbrenner’s bioecological model which illustrates the four contexts in which the child is developing, as well as the relationship between him/her and people comprised in the same environments. Proximal processes, personal characteristics of a child and the evolvement during the passage of time are also taken into consideration (Rosa & Tudge, 2013). More analytically, proximal processes considered as the “engines of development”. These are the interactions between children and others (Bronfenbrenner & Morris, 1998). The power of the process can be influenced by personal traits which consists of three types. Firstly, are the characteristics of “force” such as having the tendency to initiate and be involved in an activity. Secondly, the “resource” traits are the experiences which increase someone’s ability to be involved in the proximal processes and thirdly “demand” characteristics such as temperament or personality of person (Bronfenbrenner & Morris, 1998). Lastly, time refers to significant alterations that take place during the lifespan (Bronfenbrenner & Morris, 1998).

There are four levels in the context. Microsystem is the first one. In this, there is a direct affection in child’s development; parents or family members, friends, peers and school are usually included. How proximal processes operate in the microsystem contribute to creating and sustaining the child's development. Furthermore, the relationship in this level are bi-directional; people in this level influence the child’s behavior and vice versa (Garbarino & Ganzel, 2000). Mesosystem encompass the “interconnections” into the microsystem. An example of it can be the relationship between parents and educators that can impact a child’s development. As Bronfenbrenner (1994) states, in the exosystem, processes occur in social environments in which at least one of them does not include whoever the evolving individual is. While the child is not involved in this setting, its development is indirectly affected. The last level, macrosystem, includes all the cultural components such as religion and beliefs that can affect the development procedure as well (Bronfenbrenner, 1994). An overview of this model is provided in Figure 1.
3. Study rationale

Although positive outcomes of physical activities regarding social skills and well-being have been found in autistic children, studies investigating these effects are few. Also, in the literature review, no research has been found in which PA outcomes on social skills and well-being in preschool and age school autistic children were analyzed together. Therefore, this systematic literature review is needed to investigate potential benefits of PA on social skills and well-being. Furthermore, this study is going to present different physical activities, not concentrating on only one type.

4. Aim and research question

The aim is to investigate how participation in PA affect social skills and well-being in autistic children. The study will be guided by the following research questions:
1. What evidence can be found in research about the relationship between PA and social skills?
2. What evidence can be found in research concerning the relationship between PA and well-being?
5. Method

5.1 Systematic Literature Review

A systematic literature review was conducted to identify, summarize and critically review empirical evidence from research studies, considering specific inclusion and exclusion criteria. The aim of a systematic literature review is to assemble, synthesize and appraise evidence, meeting selection criteria, so as to answer specific research questions. The process of conducting the literature review was guided by the protocol of Jesson et al. (2011). This protocol was used to document the search and screening process involving inclusion and exclusion criteria, the extraction of information and the assessment of the quality, as well as the analysis and synthesis of the data. All these were reported with transparency to make replication of the study feasible (Jesson et al., 2011). Transparency is vital to eliminate any type of bias as well as to assess the quality and the coherence of evidence. Studies must be assembled objectively (Suri, 2020).

The PIO format (Participants, Intervention, Outcome) was utilized as an additional assistance for structuring and answering the research question (Richardson et al., 1995) and is provided in Table 1.

Table 1. PIO format

<table>
<thead>
<tr>
<th>PIO</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Autistic children</td>
</tr>
<tr>
<td></td>
<td>Pre-school and school age children (3-12 years old)</td>
</tr>
<tr>
<td>Intervention</td>
<td>Physical activities</td>
</tr>
<tr>
<td>Outcome</td>
<td>Social skills and well-being</td>
</tr>
</tbody>
</table>

5.2 Search strategy

The search for this systematic literature review was performed in February 2023. The databases utilized for the search of the articles were: MEDLINE, PubMed, ERIC, CINAHL and PsycINFO. Furthermore, the same free-text key words and phrases were used in all five databases. Boolean operators (AND, OR) as well as truncations for alternative ends of words were also applied to influence and form the search procedure. The search string included the following key words: autis* OR ASD AND "physical activit*" OR exercis* OR fitness OR sports AND "mental health" OR psychology OR "psychological health" OR anxiety OR depression OR sadness OR "well-being" AND socializ* OR "social skills" OR "soft skills" OR "social communication" OR "social
interaction" OR "interpersonal skills" OR friendship OR interaction OR "peer interaction".

In all the five databases used, a date ranges from 2012 to now was determined. Also, peer-reviewed scholarly journals were selected in ERIC and PsycINFO and academic articles in MEDLINE and CINAHL. PubMed database did not offer the option of limiting the searches in scholarly/academic articles or peer-reviewed. Lastly, the whole search procedure was documented by utilizing a protocol in which the database, dates where searches were conducted, key strings and the number of hits were included (Jesson et al., 2011).

5.3 Selection Process

5.3.1 Inclusion and exclusion criteria

Predefined inclusion and exclusion criteria determined the process of literature selection and data extraction. This study focuses on investigating how participation in PA can affect social skills and well-being in preschool and age school autistic children. Therefore, studies considering the above were taken into account. Criteria selection can be found in Table 2.

Table 2. Selection criteria

<table>
<thead>
<tr>
<th>Selection criteria</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Autistic children</td>
<td>Children under 3 years old</td>
</tr>
<tr>
<td></td>
<td>Pre-school and school age children</td>
<td>Adolescents or adults</td>
</tr>
<tr>
<td></td>
<td>(3-12 years old)</td>
<td>Other diagnosis</td>
</tr>
<tr>
<td></td>
<td>Autism diagnosis</td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>Physical activity</td>
<td>Activities which do not require body movement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>arts etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outcome</td>
<td>Social skills and well-being</td>
<td>Physical and health outcomes of PA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Academic performance</td>
</tr>
<tr>
<td>Setting</td>
<td>Outdoors/indoors</td>
<td>School context</td>
</tr>
<tr>
<td>Study Design</td>
<td>Qualitative and quantitative studies</td>
<td>Systematic review</td>
</tr>
<tr>
<td></td>
<td>Mixed methods</td>
<td>Dissertations and thesis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overview</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meta-analysis</td>
</tr>
</tbody>
</table>
5.4 Screening process

360 articles, retrieved from MEDLINE, PubMed, ERIC, CINAHL and PsycINFO were imported to Rayyan. Rayyan is a research online tool for the title and abstract screening process utilized in systematic literature reviews (Ouzzani et al., 2016). Duplicates (n=141) were removed, resulting in 219 articles for title and abstract reading. A summary of the whole screening process is provided in Figure 2.

5.4.1 Title and Abstract Screening

The title and abstract reading of 219 articles, led to the exclusion of 205 articles after the application of the selection criteria. Reasons for exclusion were wrong population, wrong outcome, wrong study design, wrong intervention or the irrelevance of the studies. The 14 remaining studies proceeded to the full-text screening.

5.4.2 Full-text Screening

During full-text screening, inclusion and exclusion criteria were applied. Of the remaining 14 articles, five articles were excluded due to wrong population. This led to nine articles in total, two were mixed-method and seven were quantitative studies.

5.5 Quality Assessment

To evaluate the methodological validity of studies, quality appraisal is needed (Jesson et al., 2011). According to the study design of each study, specific quality assessment tools were utilized.

For mixed-method studies (n=2), Mixed Method Appraisal Tool (MMAT) was used (Hong et al., 2018). The checklist contains of 5 categories (1. Qualitative, 2. Quantitative randomized-control trials, 3. Quantitative non-randomized, 4. Quantitative descriptive, 5. Mixed methods), where each one contains a total of five questions. In this case the 5th category (Mixed-methods) was utilized. The questions could be answered with Yes, No, Can’t tell; score 2 was given for YES and score 0 for NO and for Can’t tell. A calculation system was created to assess a total score. The score was 20% when MM=1; 40% when MM=2; 60% when MM=3; 80% when MM=4, and
100% when MM=5. >70% of the total score was considered as good quality, <70% and >50% as moderate quality and <50% as low quality.

For randomized control trial studies (n=2), the Joanna Briggs Institute Critical (JBI) appraisal checklist for randomized control trial studies was utilized (Tufanaru et al., 2020). This checklist contains of 13 questions, where each one could be answered with Yes, No, Unclear, Not Applicable.

For quasi-experimental studies (n=5), the JBI critical appraisal checklist for quasi-experimental studies was used (Tufanaru et al., 2020). This checklist consists of nine questions, where each one could be answered with Yes, No, Unclear, Not Applicable.

For both JBI checklists, an overall appraisal was presented in the end of the checklist, consisting of three options, Include, Exclude, Seek further info (Tufanaru et al., 2020). For the better interpretation of the quality of the studies, a score scale was created; score 2 was given for YES, 0 for NO and 1 for Unclear. If the answer was not applicable (NA), the specific scale was not calculated during the process of total score rating. >70% of the total score was considered as good quality, <70% and >50% as moderate quality and <50% as low quality. All the three quality assessment tools are illustrated in Appendix A.
**Figure 2**

*PRISMA Flowchart (Page et al., 2021)*

**Identification of studies via databases and registers**

- Records identified: 360
  - MEDLINE (n = 107)
  - PubMed (n = 148)
  - ERIC (n = 6)
  - CINAHL (n = 11)
  - PsycINFO (n = 88)

- Records removed before screening: Duplicate records removed (n = 141)

- Records screened (n = 219)

- Records excluded on title and abstract level (n = 205):
  - Wrong population (n = 11)
  - Wrong outcome (n = 14)
  - Wrong study design (n = 4)
  - Wrong intervention (n = 4)
  - Irrelevant studies (n = 172)

- Reports assessed for eligibility (n = 14)

- Reports excluded: Wrong population (n = 5)

- Studies included in review (n = 9)
5.6 Data extraction

Relevant information was extracted in an extraction protocol created in Excel program. The protocols’ structure was adjusted to the aim and research questions of the study. The following sections were included: i) article information (author, year, title of article, journal, country, aim/purpose of the study, justification of the need for this study, research question/hypothesis, study design, measurements, consent, ethical considerations) ii) participants (total number of participants, number of intervention/control/comparison group, age of participants, gender of participants, severity of autism, requirements for attending, recruitment, diagnosis, other adult participants/their role) iii) physical activity (type of physical activity, process of PA, pre-process of PA, location of PA, duration of PA, group/individual), v) outcomes (data analysis, results, conclusion, limitations, biases).

5.7 Data analysis

Analysis of the extracted data from all nine articles was based on the information from the extraction protocol. Results from the articles were incorporated to answer the research questions. To answer the first question, all evidence regarding social skills was analyzed to explore associations between social skills and participation in PA. To answer the second research question, aspects of well-being were analyzed, to find associations between aspects of well-being and participation in PA.

5.8 Ethical Considerations

As this is a systematic literature review, participants’ confidential data was not assembled. The material utilized, is publicly available and there was no obligation for ethical approval when conducting this systematic review. Yet, when conducting a systematic literature review, it is important to eliminate bias, assess quality and coherence of evidence in studies and to assemble them objectively. During the whole research procedure, transparency is crucial (Suri, 2020).

To ensure that the rights of the vulnerable group were safeguarded and that all information has been comprehended before consent to participate (Bond Sutton et al., 2003), ethical approvals and informed consents were considered when conducting this systematic literature review. Therefore, all studies ought to state if they were approved by any kind of Ethical Board or committee as well as if underaged participants gave their approval or if consent forms were assigned by at least one caregiver/parent. Of the studies (n=9), eight stated both approval from an Ethical Board and informed consent by participant’s caregivers/parents.
6. Results

6.1. Characteristics of selected studies

In this systematic literature review nine studies that met the selection criteria were included. Eight studies were considered as having a high quality (1, 2, 3, 5, 6, 7, 8, 9) and one as having moderate quality (4). Study 9 did not provide any information on ethical considerations but was included in this paper as it contributes to the holistic understanding of the research topic. However, this lack of data regarding ethical considerations is considered as a weakness. Also, the JBI tool used to assess the quality of this study did not include any explicit assessment on ethical criteria. An overview of the included studies, including authors and year, title, country, aim, name of the program/intervention and a summary of findings is provided in Table 3. To simplify citation, each study was given a specific identification number (ID).

Five studies out of nine were quantitative and utilized quasi-experimental design (1, 2, 3, 7, 9), two were quantitative with randomized-control trials (5, 8) and two were mixed method studies (4, 6). Studies were conducted in many different geographical environments; out of the nine studies three were set in China (2, 7, 9), two in USA (1, 4), one in Turkey (6), one in Australia (3), one in Iran (5) and one in Israel (8). All of them were academic journals and published between 2012 to 2023.

There were several types of PA; aquatic occupational therapy (1), mini-basketball training program (MBTP) (2, 7), organized physical activity program (OPA) (3), swim program (4), Sports, Play and Active Recreation for Kids (SPARK) program (5), inclusive physical activity program (IPA) (6), outdoor adventure program (8), and structured physical activity program (9). Eight out of nine PA were group activities (1, 2, 3, 5, 7, 8, 9) while only one was individual (4). The duration of the PA interventions was 12-24 weeks. Knowing that most therapeutic blocks are normally six weeks long, a common length for certain types of structured programs or courses, most of the interventions in this study were very long.

6.2 Characteristics of participants

Participants were aged 3 to 12 with low (6), mild to moderate (8), mild to severe (1, 9), severe (2, 3, 7) level of autism. Two studies did not specify the level of autism severity (4, 5). Most participants were male and the number of participants in the studies ranged from 7 to 30. One study did not specify the number of males: females (5). An overview of the characteristics of participants is provided in Table 4.
<table>
<thead>
<tr>
<th>ID</th>
<th>Authors (Year)</th>
<th>Title</th>
<th>Country</th>
<th>Aim of the study</th>
<th>Program-Intervention</th>
<th>Summary of findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alaniz et al. (2017)</td>
<td>The Effectiveness of Aquatic Group Therapy for Improving Water Safety and Social Interactions in Children with Autism Spectrum Disorder: A Pilot Program</td>
<td>USA</td>
<td>To investigate the feasibility and impact of an aquatic based occupational therapy provided in a small group setting on swim skills and social skills in children with mild to severe ASD.</td>
<td>Aquatic occupational therapy</td>
<td>No improvements in social skills</td>
</tr>
<tr>
<td>2</td>
<td>Cai et al. (2020)</td>
<td>Mini-Basketball Training Program Improves Social Communication and White Matter Integrity in Children with Autism</td>
<td>China</td>
<td>(i) To investigate whether a mini-basketball training program (MBTP) serving as adjuvant therapy, could improve social communication (SC) deficit (ii) To evaluate whether MBTP can influence white matter integrity (WMI) in ASD children by analyzing WMI changes via diffusion tensor imaging (DTI) (iii) To examine possible neurobehavioral relationships between physical exercise-induced WMI changes and SC deficit</td>
<td>Mini-Basketball Training Program (MBTP)</td>
<td>Improvements in social communication and social cognition</td>
</tr>
<tr>
<td>3</td>
<td>Howells et al. (2020)</td>
<td>Can Participation in a Community Organized Football Program Improve Social, Behavioural Functioning and Communication in Children with Autism Spectrum Disorder? A Pilot Study</td>
<td>Australia</td>
<td>i) To assess whether there was a difference in social, communicative and behavioral outcomes between a group of children with ASD who participated in Australian rules junior football programs (Auskick) and a group of children with ASD who were not engaged in the football program ii) To assess the relationship between the number of sessions attended and any differences in pre-and-post scores, and any group differences between the type of program attended (mainstream or disability-focused) and pre-and-post scores in children who participated in the football program.</td>
<td>Organized Physical Activity Program (OPA)</td>
<td>Decreases in internalizing and anxiety problem behaviors Decreases in social problems for subgroup 6–12-year-olds children with ASD No changes on social skills areas (social communication and socialization)</td>
</tr>
<tr>
<td>4</td>
<td>Johnson et al. (2021)</td>
<td>Swim Program Pilot for Children with Autism: Impact on Behaviors and Health</td>
<td>USA</td>
<td>To assess parental psychological health and child behaviors before and after a private swimming program for children aged between 5.5 and 11 years with ASD.</td>
<td>Swim program</td>
<td>Reduction in challenging behaviors (compliant/calm, hyperactive, self-injury/stereotypies) Improvements in overly sensitive domain Less conduct problems</td>
</tr>
<tr>
<td>ID*</td>
<td>Authors (Year)</td>
<td>Title</td>
<td>Country</td>
<td>Objective</td>
<td>Intervention</td>
<td>Findings</td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
<td>-------</td>
<td>---------</td>
<td>-----------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>5</td>
<td>Najafabadi, et al. (2017)</td>
<td>The effect of SPARK on social and motor skills of children with autism</td>
<td>Iran</td>
<td>To examine the effectiveness of the Sports, Play and Active Recreation for Kids (SPARK) program on balance, coordination (motor skills) and social impairments of children with ASD.</td>
<td>Sports Play and Active reaction for kids (SPARK)</td>
<td>Improvements in motor skills and social interaction</td>
</tr>
<tr>
<td>6</td>
<td>Sansi et al. (2020)</td>
<td>Effects of an Inclusive Physical Activity Program on the Motor Skills, Social Skills and Attitudes of Students with and without Autism Spectrum Disorder</td>
<td>Turkey</td>
<td>To investigate the effects of an IPA program on the motor skills, social skills and attitudes of students with and without ASD.</td>
<td>Inclusive Physical Activity Program (IPA)</td>
<td>Positive effect on the motor skills on students with ASD; Change peer attitudes, establishing close relationships; qualitative data but no statistically significant differences; quantitative data No changes in social skills; positive changes from interviews Reduction in internalizing problems</td>
</tr>
<tr>
<td>7</td>
<td>Wang et al. (2020)</td>
<td>Effects of Mini-Basketball Training Program on Executive Functions and Core Symptoms among Preschool Children with Autism Spectrum Disorders</td>
<td>China</td>
<td>To investigate the effects of an exercise intervention program on executive function and core symptoms of ASD in a sample of 3–6-year-old preschoolers with ASD.</td>
<td>Mini-Basketball Training Program (MBTP)</td>
<td>Improvements in social communication and repetitive behavior</td>
</tr>
<tr>
<td>8</td>
<td>Zachor et al. (2017)</td>
<td>The effectiveness of an outdoor adventure program for young children with autism spectrum disorder: a controlled study</td>
<td>Israel</td>
<td>To investigate the impact of the outdoor adventure program on severity of autism symptoms, adaptive skills and teachers’ perception of the child’s expected future capabilities.</td>
<td>Outdoor Adventure Program</td>
<td>Improvements in social cognition, social communication and autistic mannerisms; Improvements in communication and daily living adaptive skills; More enjoyment and reduction in anxiety; instructors’ perceptions</td>
</tr>
<tr>
<td>9</td>
<td>Zhao &amp; Chen (2018)</td>
<td>The Effects of Structured Physical Activity Program on Social Interaction and Communication for Children with Autism</td>
<td>China</td>
<td>To investigate the effectiveness of a structured physical activity program on social interaction and communication skills of children with ASD.</td>
<td>Structured physical activity program</td>
<td>Improvements in the social skills (communication, cooperation, and self-control, social interaction</td>
</tr>
</tbody>
</table>

ID*: study identification number
6.3 The relationship between PA and social skills

All studies investigated potential benefits of PA on social skills. Each study utilized specific measurements to do so. Subdomains of social skills have been identified and are presented in Table 5. Effect sizes for three (2, 7, 8) studies were identified and also presented in the table. Study 5 did not present effect size for social interaction subdomain, but this was calculated from the given data. Study 9 only provided an effect size for the social interaction subdomain, but effect sizes for the other subcategories were calculated from the data provided. Results from study 6 were qualitative. Improvements have been found in six out of 13 subdomains of social skills; social communication (2, 6, 7, 8, 9), social interaction (5, 9), co-operation (9), self-control (9) and social cognition (2, 8). A reduction in autistic mannerisms was also observed (8).

<table>
<thead>
<tr>
<th>ID</th>
<th>N in intervention group</th>
<th>Age range</th>
<th>Male (M): Female (F)</th>
<th>Severity of autism</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>3-7</td>
<td>6:1</td>
<td>Mild to severe</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>3-6</td>
<td>12:3</td>
<td>Severe level (CARS 41.20)</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
<td>5.2 – 12.3</td>
<td>17:2</td>
<td>Severe level (SRS-2 76.28)</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>5.5-11</td>
<td>7:3</td>
<td>Not specified</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>5-12</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>6</td>
<td>22</td>
<td>6-11</td>
<td>12:1 (first group)</td>
<td>Low level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7:2 (second group)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>18</td>
<td>3-6</td>
<td>28:5</td>
<td>Severe level (CARS 45.94)</td>
</tr>
<tr>
<td>8</td>
<td>30</td>
<td>3.4-7.4</td>
<td>26:4</td>
<td>Mild to moderate</td>
</tr>
<tr>
<td>9</td>
<td>21</td>
<td>5-8</td>
<td>14:7</td>
<td>Mild to severe</td>
</tr>
</tbody>
</table>

ID*: study identification number
Table 5

<table>
<thead>
<tr>
<th>Social skills</th>
<th>ID</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>Effect Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social communication</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>( \eta^2 = 0.272 ) (2), ( d = 0.528 ) (7), ( \eta^2 = 0.079 ) (8), ( \eta^2 = 0.578 ) (9)</td>
</tr>
<tr>
<td>Socialization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social interaction</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \eta^2 = 0.33 ) (5) ( \eta^2 = 6.95 ) (9)</td>
</tr>
<tr>
<td>Co-operation</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \eta^2 = 0.52 ) (9)</td>
</tr>
<tr>
<td>Self-control</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \eta^2 = 0.37 ) (9)</td>
</tr>
<tr>
<td>Assertion</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsibility</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social awareness</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social cognition</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \eta^2 = 0.305 ) (2), ( \eta^2 = 0.099 ) (8)</td>
</tr>
<tr>
<td>Social motivation</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autistic mannerisms</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \eta^2 = 0.143 ) (8)</td>
</tr>
<tr>
<td>Empathy</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** X= subcategories in studies; X = improved domains in studies

6.3.1 Social skills

Social communication was the most commonly subdomain used (1, 2, 3, 6, 7, 8, 9) with the most positive results (2, 6, 7, 8, 9). A large improvement in this subdomain was observed after the Mini-Basketball Training Program (MBTP) (2). While quantitative data did not find any changes in children’s communication skills after participation in inclusive physical education (IPA), parents’ and special education teachers’ perspectives indicate that their communication skills were improved (6). There was a medium enhancement in social communication after the 12-week MBTP (7). After the outdoor adventure program, the intervention group showed a medium improvement in social communication. Yet, teachers’ perception regarding students’ future socio-communication skills did not alter over time (8). There was a very large enhancement on children’s communication skills after the 12-week physical activity program (9). No improvements were found in the control group (2, 7, 8, 9).

Communication areas did not change after 8 hours of aquatic occupational therapy (1). No significant differences were observed in communication skills after participation in the Organized Physical Activity program (OPA) (3).

All studies that have investigated social interaction (5, 9) and social cognition (2, 8) observed improvements in these domains. Regarding social cognition, small to medium (2) as well as medium (8) improvements were observed while a very large increase was found in
social interaction skills (5, 9). No improvements were observed in the control group (2, 5, 8, 9).

While there were large improvements in co-operation and self-control after the structured physical activity program (9) and a high improvement in autistic mannerisms areas after the outdoor adventure program (8), other studies did not find any positive enhancements (1, 6) and (2) respectively. No improvements were found in the control group (8, 9).

All studies that have investigated socialization (3, 8), assertion and responsibility (1, 6, 9), social awareness (2, 8), social motivation (2, 8), empathy and engagement areas (1, 9) found no improvements in these areas.

6.4 Behavioral problems and adaptive behaviors

Behavioral problems and adaptive behaviors subdomains related to social skills have also been taken into consideration. Effect sizes for all significant results were also identified. All these are presented in Table 6.

<table>
<thead>
<tr>
<th>Behavioral Problems</th>
<th>ID</th>
<th>1</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>7</th>
<th>Effect Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Externalizing problems</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social problems</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>η²=0.17</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>d=0.362</td>
</tr>
<tr>
<td>Repetitive behaviors</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>d=0.447</td>
</tr>
<tr>
<td>Adaptive/social</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conduct problems</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>d=0.295</td>
</tr>
<tr>
<td>Self-injury stereotypic</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>d=0.362</td>
</tr>
<tr>
<td>Self-isolated/Ritualistic</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bullying</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autism spectrum symptoms</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: X= subcategories in studies; X = improved domains in studies

6.4.1 Behavioral problems

Regarding behavioral problems, a large decrease has been found in social problems after the OPA program (3), a small to medium decline in hyperactivity after the swim group program (4), a medium decrease in repetitive behaviors after MBTP (7), and a small decrease in conduct problems and in self-injury stereotypic after the swim program (4). No changes were found in scores for the comparison group (3) and the control group (7).

No improvements have been found in externalizing problems after the aquatic physical program, the OPA and the IPA (1, 3, 6), hyperactivity after aquatic group therapy
and IPA (1, 6), adaptive/social subscale and self-isolated/ritualistic after the swim program (4) as well as bullying and autism spectrum symptoms after aquatic group therapy (1).

### 6.4.2 Adaptive behaviors

Regarding adaptive behaviors, a medium to large improvement has been found in communication and a large enhancement in daily living skills after participation in the outdoor adventure program (8).

### 6.5 The relationship between PA and well-being

Four studies (3, 4, 6, 8) presented information regarding well-being in autistic children after participation in PA. Subdomains of behavior and emotional scales as well as information from adult perspectives were identified and presented in Table 7. Effect sizes of two (3, 4) studies were also identified and presented in the table. One study (6) did not present any effect sizes and these were not calculated because data were not provided. Results from study 8 were qualitative. A reduction has been found in anxiety, internalizing problems and overly sensitive subcategories while improvements have been found in the compliant/calm and enjoyment ones.

**Table 7. Subcategories of well-being**

<table>
<thead>
<tr>
<th>Well-being</th>
<th>ID</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>Effect Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>$\eta^2=.24$ (3)</td>
</tr>
<tr>
<td>Depression</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internalizing problems</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>$\eta^2=.15$ (3)</td>
</tr>
<tr>
<td>Compliant/calm</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>d=0.29</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insecure/Anxious</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overly sensitive</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>d=0.45</td>
</tr>
</tbody>
</table>

*Note: X= subcategories in studies; X = improved domains in studies*

Regarding well-being, a large improvement has been found in anxiety subdomain after participation in the Organized Physical Activity (OPA) program (3). A reduction in the level of anxiety during the outdoor adventure program was also observed by instructors (8). There was a large decrease in internalizing problems for the intervention group after participation in the OPA program (3) while a decrease was found in only one group of autistic children after participation in the Inclusive Physical Activity Program (IPA) (6). Small changes found in the
compliant/calm subcategory, indicate that autistic children were found to be more compliant/calmer after participation in the swim program. Findings from interviews by caregivers verified this result, as according to them their children were sleeping and behaving better after the completion of the swim program (4). A high sense of enjoyment throughout the activities of the outdoor adventure program was observed by instructors (8). Small to medium changes were found in the overly sensitive subcategory, indicating that children were less overly sensitive after participation in the swim program (4). No changes in the anxiety and internalizing scores were observed for the comparison group (3).

Improvements have neither been observed in depression symptoms after participation in the OPA program (3) nor in the insecure/anxious subdomain after participation in the swim program (4).

6.6 The impact of PA on other aspects

6.6.1 Peer attitudes/Relationships

While changes in peer attitudes of non-autistic students were not observed through statistical analysis, perceptions of neurotypical peers showed that there were positive changes in their attitudes. More specifically while neurotypical peers used to be afraid of or even felt shy towards their autistic peers, this behavior changed after the completion of the IPA program as they could communicate better with them and were not being afraid of them anymore. Close relationships were established through the IPA program (6).

6.6.2 Motor skills

Some fundamental movement skills (FMS), locomotor skills and ball skills, enhanced after the 12-week IPA program. This finding was also supported by the perceptions of the parents of autistic children, special education teachers and voluntary physical education teachers where according to them children’s motor skills enhanced. They also stated that children were more interested in physical activities after their participation in the IPA program (6). Motor skills in autistic children, balance (dynamic and static) and bilateral coordination, improved after participation in the 12-week of SPARK program (5).
7. Discussion

This systematic literature review aimed at identifying potential benefits on social skills and well-being for preschool and school-aged autistic children after participating in physical activity (PA). The findings are going to be discussed using Bronfenbrenner’s bioecological model focusing on individuals’ personal characteristics.

There are several different terms used to describe social skills and interpersonal relationships. For the discussion to be more comprehensible, “social skills” and “relationships” were used as common terms.

7.1 Force characteristics

Force characteristics are those that motivate a person to initiate and be involved in an activity (Bronfenbrenner & Morris, 1998). They work as psychological nudges which are elements of supportive environments that can encourage positive behaviors (Thaler & Sunstein, 2008).

7.1.1 Relationship between autistic children and neurotypical peers after participation in PA

Autistic children face difficulties in creating friendships as the procedure of conquering the necessary social skills seems demanding for them (Klinger et al., 2007). Also, as double empathy highlights, understanding each other’s perspectives is a difficult process for both neurotypical and autistic children (Milton, 2012). Our findings showed that peer attitudes towards autistic children changed positively according to non-autistic children’s perspectives. After the end of the Inclusive Physical Activity (IPA) program they considered them as friends (Sansi et al., 2021). Both autistic and non-autistic children found a way to communicate and understand each other (Milton, 2012). Other studies found similar results. Autistic children who participated in more physical activities, were found to have at least one friend (Dovgan & Mazurek, 2019). The interaction with peers was enhanced after participation in PA (Hortal-Quesada & Sanchis-Sanchis, 2022). An enhancement in relationships was also observed in Hayward et al. (2016) study as according to their findings, after a community-based soccer program, interactions with siblings were boosted. Sporting programs such as soccer empowered relationships as well (Cei et al., 2017).

Social cognition is required for relationships to arise (Webster & Carter, 2007). According to our findings, social cognition was enhanced through participation in Mini-Basketball Training Program (Cai et al., 2020) and in Outdoor Adventure Program (Zachor et al., 2017).
7.1.2 Well-being in autistic children after participation in a PA

Autistic children were found to have lower levels of self-esteem and happiness than neurotypical children (McChesney & Toseeb, 2018). Numerous studies have shown that depression usually co-occurs with anxiety and individuals with depression might also experience symptoms of anxiety (Tiller, 2013). Sleeping difficulties have also been reported by many patients with depression (Franzen & Buysse, 2008). Higher levels of anxiety and depression in this population can be due to the difficulties in social situations and in relationships, as a result of non-acceptance or misunderstanding by other individuals (National Autistic Society, n.d.) or because of the difficulty for both neurotypical and autistic children in understanding each other (Milton, 2012). Furthermore, environments and social contexts which do not accommodate neurodiversity contribute negatively as well (Hwang & Hughes, 2016). Factors such as low self-confidence and low self-esteem (Arnell et al., 2020) can lead to a decreased motivation for engagement in physical activities for autistic children (Pan et al., 2011).

Findings in this study showed improvements in well-being of autistic children after participation in PA. More analytically, a large reduction of anxiety in autistic children was found after the Organized Physical Activity (OPA) program (Howells et al., 2020) and the outdoor adventure program (Zachor et al., 2017). Children were also sleeping better after swim program while they were found to be more compliant/calmer as well (Johnson et al., 2021). Internalizing problems decreased after participation in the OPA program (Howells et al., 2020) and a reduction in that domain was also observed in one group of autistic children who took part in the Inclusive Physical Activity (IPA) program (Sansi et al., 2021). Instructors of the outdoor adventure program support that autistic children seemed to enhance their feeling of enjoyment during the program (Zachor et al., 2017). Other studies observed similar findings. More specifically, Dimech and Seiler (2011) found that sporting programs such as soccer reduced anxiety while short-term reductions were also found in internalizing areas after a low-level physical exercise and relaxation program in autistic people (Hillier et al., 2011). What is more, sporting programs such as soccer improved the mood in autistic children (Hayward et al., 2016).

Depressive syndromes are common in numerous autistic children. Autistic traits can mask fundamental features of depression and symptoms of depression in children with autism might be atypical (Lainhart & Folstein, 1994; Simonoff, 2008). According to our findings, depression was not decreased after participation in OPA program (Howells et al., 2020). Findings from other studies agree by presenting no reductions in depression (Garcia-Gomez et al., 2014). This might happen as it is hard to identify depressive symptomatology in autistic
people (Lainhart & Folstein, 1994). Moreover, the characteristics of depression in autistic children can be complicated due to the social, cognitive, and communicative deficits that characterize autism (Stewart, 2006).

In summary, there were improvements in peer relationships and friendships were created after participation in PA. Well-being aspects were also improved. These enhancements can be considered as motivational factors which can help autistic children to boost their eagerness and motivation to participate in PA (Bronfenbrenner & Morris, 1998).

7.2 Resource characteristics

Resource characteristics include mental and emotional resources such as past experiences, skills and intelligence of a person as well as material resources such as having access to social and material support such as education. Altogether resource characteristics influence someone’s ability to engage in proximal processes (Bronfenbrenner & Morris, 1998).

7.2.1 Social skills in autistic children after participation in a PA

Autistic children face difficulties with social communication and interaction as a result of lacking in these domains (Centre for Disease Control and Prevention [CDC], n.d.) as well as because of the difficulty for both of autistic and non-autistic individuals in understanding each other (Milton, 2012). In hospitable environments that do not accommodate neurodiversity increase this difficulty as well (the Social Model of Disability, 2013). Social difficulties make the ability of participation in any kind of structured and unstructured types of physical activity difficult for them (Must et al., 2015).

According to our findings, social skills in autistic children were improved after participation in PA. The subdomains which showed improvement were social communication (Cai et al., 2020; Sansi et al., 2021; Wang et al., 2020; Zachor et al., 2017; Zhao & Chen, 2018), social interaction (Najafabadi et al., 2018; Zhao & Chen, 2018), co-operation and self-control (Zhao & Chen, 2018), social cognition (Cai et al., 2020; Zachor et al., 2017) and autistic mannerisms (Zachor et al., 2017). Our findings are in line with previous studies indicating that people benefited from participation in sports or in regular exercises (Silva et al., 2020).

As can be seen from our results, the communication subdomain has been investigated in a majority of the studies. Communication is an essential key in daily life, as relationships can be built through it. Sharing of feelings, information and thoughts as well as experiences and needs, leads to connection with other people (the Chartered Institute of Payroll Professionals [CIPP], 2022). Studies have shown that communication skills were enhanced after participation in exercise (Hameury et al., 2010; Pan, 2010). Same with our findings
where the mini-basketball training program (Cai et al., 2020; Wang et al., 2020), the inclusive physical activity program (Sansi et al., 2021), the outdoor adventure program (Zachor et al., 2017), and the structured physical activity program (Zhao & Chen, 2018) improved children’s communication skills.

Autistic people face difficulties in comprehending other individual’s goals, intentions, and emotional situations, also called theory of mind (Baron-Cohen et al., 2015). Cognitive impairments affect social interactions negatively (Twachtman-Cullen, 2000). Regarding our findings, areas of social cognition in autistic children were improved by participation in MBTP (Cai et al., 2020) and in the outdoor adventure program (Zachor et al., 2017). Responsibility in autistic children was also enhanced through participation in structured physical activity program (Zhao & Chen, 2018). This is in line with the National Autism Center (2015) where according to it physical activity program can motivate autistic children to start taking responsibilities.

While Najafabadi et al. (2018) and Zhao and Chen (2018) found improvements in social interaction subdomain after participation in Sports Play and Active reaction for Kinds (SPARK) and in structured physical activity program respectively, no improvements were found in the area of socialization after the organized physical activity program (Howells et al., 2020) and the outdoor adventure program (Zachor et al., 2017). This might happen as social interaction and socialization are two different things, a difference which is worth being distinguished. The former has to do with companionship; when people getting together in order them to talk or play. The latter happens when someone is considered as a member of a society/community. Social interaction might be an aspect of socialization yet, socialization is “to function successfully in society” meaning that material (objects produced or utilized by humans) and nonmaterial culture (language, norms, symbols) must be conquered (Little, 2013).

7.2.2 Motor skills in autistic children after participation in a PA

Autistic children have been found to have various motor skills impairments in comparison to neurotypical peers (Crucitti et al., 2019). These impairments can range from kicking or catching a ball to balance and jump (Green et al., 2009; Staples & Reid, 2010) to deficits in coordination skills (Srinivasan et al., 2015). Due to these impairments, their participation in activities that can improve the development of communication and interaction skills is limited (Bhat et al., 2011). According to our findings, autistic children enhanced their motor skills, after they took part in the 12-week IPA (Sansi et al., 2021) and SPARK program (Najafabadi et al., 2018). Regarding the IPA program, parents’ and physical educators’ perspectives confirm the above finding by giving examples of how children’s motor skills
increased (Sansi et al., 2021). They also stated that children were more interested in physical activities after their participation in the IPA program. These findings are in line with Pan, (2011) who found that through participation in inclusive physical activities (IPA) motor skills developed efficiently. Other studies also agree with our findings by supporting that numerous physical activities enhanced the motor skills of autistic individuals (Chu & Pan, 2012; Hutzler & Margalit, 2009).

In summary, improvements in social and motor skills in autistic children work as new skills and good experiences which can increase their ability to take part in PA (Bronfenbrenner & Morris, 1998).

### 7.3 Demand characteristics

Demand characteristics include specific aspects of behavior, that are immediately distinct and can encourage or discourage the motion of processes (Bronfenbrenner & Morris, 1998).

Behavioral deficits are barriers to participation in structured and unstructured physical activities (Must et al., 2015). These can lead autistic children to inactivity (Pan, 2009). Challenging behaviors can lead to poor social adaptation (Hartley et al., 2008). Evidence that physical exercises can decrease challenging behaviors in autistic children has been illustrated by studies (Hortal-Quesada & Sanchis-Sanchis, 2022). What is more, behavioral problems decreased through running exercises (Tse, 2020) as well as through martial arts (Greco & De Ronzi, 2020). Our findings are in line with all previous evidence as they show that some subdomains of behavioral problems decreased after participation in several PA. More specifically, there was a reduction in social problems after participation in organized physical activity program (Howells et al., 2020), a decrease in hyperactivity, conduct problems and self-injury stereotypic behaviors after swim program (Johnson et al., 2021) and a reduction in repetitive behaviors after mini-basketball training program (Wang et al., 2020). Adaptive behaviors (communication and daily living skills subdomains) were enhanced after the outdoor adventure program as well (Zachor et al., 2017).

The reduction of challenging behaviors in autistic children, can encourage their participation in PA as positive reactions from social environment will be created (Bronfenbrenner & Morris, 1998).

### 7.4 Limitations and future research

Findings regarding social skills and well-being were very few due to the extremely limited research. Findings about social skills and well-being in autistic children after participation in PA should be treated with caution. One study (Alaniz et al., 2017) found no improvements in social skills, yet there was an increase rate of noncompliance with the
completion of the form which prevented the statistical analysis of the data; only two out of seven parents completed it. Sample sizes in all studies were small to modest; seven to 30 participants. Two studies did not specify the level of autism severity (Johnson et al., 2021; Najafabadi et al., 2018) and the remaining seven studies included several levels of autism severity. Thus, participants have different abilities and difficulties. Regarding gender, males outnumbered females in all studies that mentioned the gender. Two studies did not include a control group. Furthermore, parents’, teachers’ and instructors’ proxy reports cannot be fully representative as they do not reflect children’s view and they might be affected by context. Caregivers and participants were not blinded in Howells et al. (2020) and Najafabadi et al. (2018) studies, so observer bias might not have been prevented. Other routines such as treatment or medication were not controlled in Howells et al. (2020) study. Demographic and socioeconomic information were not considered in Wang et al. (2020) and Alaniz et al. (2017) studies respectively whereas ethical considerations were not stated in Zhao & Chen (2018) study. Since the current study was conducted by one researcher, there is a risk of bias due to subjectivity. Lastly, results were combined and presented in sub-categories in a subjective manner.

As some types of physical activities showed more positive results than others, it might be interesting future research to focus on the comparison of several types of PA regarding social skills and well-being in children with autism. Except social communication skills which have been investigated in a majority of the studies, other various social skills subdomains need to be investigated more. Follow-up analysis should be conducted in order long-lasting effects of PA to be identified. Effect sizes should be calculated and presented in every study to see if the improvements in these domains are meaningful or not.

7.5 Implications

Social skills and well-being are important aspects for the participation in physical activities (PA) of autistic children. Numerous social skills subdomains should be gathered and measured accordingly to get a clearer picture about what aspects can be improved. Well-being subdomains should also be identified to measure positive effects. Other aspects such as motor skills and relationships should also be taken into consideration as they play a crucial role when it comes to the ability of participating in PA and to the well-being of person.

8. Conclusion

Autistic children have deficits in social skills and face behavioral difficulties. Also, there is a mutual difficulty for both autistic and non-autistic individuals in comprehending each other’s perspectives and experiences. Social difficulties that autistic children experience
are not only due to medical deficits of autism but also due to the inappropriate environments and social contexts which do not accommodate neurodiversity. Those are barriers to their participation in any kind of structured and unstructured physical activity. People with disabilities have the same right as others to engage in physical activities and sports. All the above in combination with the medicalization of autism that leads to stereotypes and misconceptions lead autistic children to have lower levels of quality of life and lower level of self-esteem and happiness.

This systematic literature review contributes to the existing knowledge by providing an overview of how participation in PA affect social skills and well-being in autistic children. MRC complex intervention approach can tailor PA programs to the needs of autistic children to achieve desired outcomes. Benefits regarding social skills have been found in the majority of studies in social communication, social interaction, co-operation, self-control, social cognition and autistic mannerisms subdomains. Behavioral problems and adaptive behaviors that are related to social skills have also been investigated. Regarding the former, improvements in social problems, hyperactivity, repetitive behaviors, conduct problems and self-injury stereotypic subdomains were observed while regarding the latter, enhancements in communication and daily living skills subcategories were identified. While the enhancement of well-being in autistic children after participation in PA as well as findings concerning motor skills and peer relationships seemed promising, no clear statement can be made about the efficacy of PA in these domains due to the lack of data.
9. References


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## Appendix A. Quality Assessment Tools

### Results Quality Assessment JBI, for RCT studies

<table>
<thead>
<tr>
<th>Study</th>
<th>1. Was true randomization used for assignment of participants to treatment groups?</th>
<th>2. Was allocation to treatment groups concealed?</th>
<th>3. Were treatment groups similar at the baseline?</th>
<th>4. Were participants blind to treatment assignment?</th>
<th>5. Were outcomes assessors blind to treatment assignment?</th>
<th>6. Were treatment groups treated identically other than the intervention of interest?</th>
<th>7. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?</th>
<th>8. Were participants analyzed in the groups to which they were randomized?</th>
<th>9. Were outcomes measured in the same way for treatment groups?</th>
<th>10. Were outcomes measured in a reliable way?</th>
<th>11. Were appropriate statistical analysis used?</th>
<th>12. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?</th>
<th>Total score of quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zachor et al. (2017)</td>
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<td>2</td>
<td>1</td>
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<td>Najafabadi et al. (2017)</td>
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</tr>
</tbody>
</table>

Note: Yes = 2; Unclear = 1; No = 0; NA = 3; Quality score: High >70%; Moderate <70% and >50%; Low <50%
## Results Quality Assessment JBI for Quasi Experimental studies

| Study              | 1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)? | 2. Were the participants included in any comparisons similar? | 3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest? | 4. Was there a control group? | 5. Were there multiple measurements of the outcome both pre and post the intervention/exposure? | 6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed? | 7. Were the outcomes of participants included in any comparisons measured in the same way? | 8. Were outcomes measured in a reliable way? | 9. Was appropriate statistical analysis used? | Total score of quality |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Wang et al. (2020) | 2                                                                                                                                  | 2                                                               | NA                                                                                                                               | 2                          | 2                                                                                                                              | 2                                                                                                                              | 2                                                                                                                              | NA                                                                                                                               | 2                                                                                                                              | High (94%)                                                                                                                                 |
| Cai et al. (2020)  | 2                                                                                                                                  | NA                                                              | NA                                                                                                                               | 2                          | 2                                                                                                                              | NA                                                                                                                              | 2                                                                                                                              | 2                                                                                                                              | 1                                                                                                                              | High (92%)                                                                                                                                 |
| Alaniz et al. (2017)| 2                                                                                                                                  | 2                                                               | NA                                                                                                                               | NA                        | 2                                                                                                                              | NA                                                                                                                              | NA                                                                                                                              | NA                                                                                                                               | 2                                                                                                                              | High (100%)                                                                                                                                 |
| Zhao & Chen (2018) | 2                                                                                                                                  | NA                                                              | 2                                                                                                                                | 2                          | 2                                                                                                                              | NA                                                                                                                              | 2                                                                                                                              | 1                                                                                                                              | 2                                                                                                                              | High (93%)                                                                                                                                 |
| Howells et al. (2020)| 2                                                                                                                               | 2                                                               | 2                                                                                                                                | NA                        | 2                                                                                                                              | 2                                                                                                                              | 2                                                                                                                              | 2                                                                                                                              | 2                                                                                                                              | High (100%)                                                                                                                                 |

*Note: Yes = 2; Unclear = 1; No = 0; NA = 3*; Quality score: High >70%; Moderate <70% and >50%; Low <50%
Mixed Methods Appraisal Tool (MMAT), version 2018

<table>
<thead>
<tr>
<th>Category of study designs</th>
<th>Johnson et al. (2021)</th>
<th>Sansi et al. (2020)</th>
</tr>
</thead>
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<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Mixed-Method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Is there an adequate rationale for using a mixed method design to address the research question?</td>
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</tr>
<tr>
<td>2. Are the different components of the study effectively integrated to answer the research question?</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Yes =2; No=0; Can’t tell=0; Quality score: High >70%; Moderate <70% and >50%; Low <50%

Moderate (60%) High (100%)