

AN INTRODUCTION ON THE BENEFITS OF MOTOR AND SPORTS ACTIVITIES ON SENSORY PROCESSING IN CHILDREN WITH AUTISM SPECTRUM DISORDER (ASD)

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Abstract: ASD is a neurodevelopmental disorder characterized by deficits in behavior and communication and social interaction of the diagnosed person, having negative consequences on functioning and performance in different areas. With different forms of manifestation and degrees of impairment, the individual with ASD presents difficulties in contextual and/or sensory perception of stimuli, which causes maladaptive responses from him/her, often accompanied by motor difficulties. The purpose of this article is to identify the existence of the benefits that the practice of motor and sports activities have on sensory processing in children with ASD. The results highlight that there are associations between sensory processing difficulties and motor impairments, even from the first years of life, with the motor and sensory areas being in neural connection and developing at the same time at an accelerated pace. Practicing motor and sports activities leads to improvements in different areas: physical and mental health, motor skills (oral and visual, gross and fine motor skills, manual dexterity, balance, ability to relax and control body movements), cognitive and sensory processing (memorization, sequencing, attention, cognitive flexibility, inhibitory control of body movements, academic performance), communication and social interaction skills (establishing and maintaining friendships, acceptance from others), adaptive behaviors (reduction of stereotyped and self-aggressive behaviors, self-stimulation, hyperkinetic behavior).

Key words: children with ASD, sensory processing, benefits of physical and sports activities, psychomotor development

Introduction

Autism spectrum disorder (ASD) is part of the group of neurodevelopmental disorders (Diagnostic and Statistical Manual of Mental Disorders -V, 2013) which are defined by the presence of two categories of symptoms: persistent impairments in communication and social interaction in multiple contexts, as well as patterns of behavior, interests, restrictive and repetitive activities. It is persistent throughout life, some symptoms can be observed in the first year of life, but most are visible between 1–2 years, the functioning and performances in the physical, mental, academic and social areas being negatively affected (Peeters, 2009).

Information integration processes (contextual and/or sensory perceptions) are unbalanced, which causes qualitative alterations in the areas of communication and behavior of an individual with ASD. The information received from the environment is taken up with the help of the sensory organs, the brain being able to process it

fragmented like separate puzzle pieces and different, unadapted and non-functional. It takes more time to adjust reactions, process and arrange information as a whole puzzle.

Several studies show that individuals with ASD have a spectrum of sensory processing disorders. They can be mildly affected (sensory differences) or more pronounced (sensory difficulties) going up to a severe impairment (sensory dysfunctions) (Ayres, 2005; Stock Kranowitz, 2022; Oster & Zhou, 2022). The individual's sensory systems (visual, auditory, vestibular, gustatory, olfactory, proprioceptive and tactile) process information from the environment differently, the brain of a child with ASD adapting the functional reactions differently. Depending on the degree of sensitivity to the stimuli received, the individual with ASD has different behaviors (hyper-reactivity, hypo-reactivity, sensation seeking).

Studies also show that a significant percentage of children with ASD have not only sensory difficulties, but motor difficulties as well, the neural connections between these areas being complex and dependent. Therefore, the introduction of motor and sports activities in intervention programs for children with ASD can positively influence the level of physical, mental, social motor health, as well as cognitive and sensory processes.

Materials and Methods

The purpose of this article is to identify the existence of positive effects that the practice of motor and sports activities have on sensory processing in children with ASD. For this, bibliographic references published in several databases (Web of Science, Scopus Database, PubMed, Google Scholar, ResearchGate) were searched, using several key words "benefits/effects of motor activities/exercises among children with ASD", "sensory processing/integration for children with ASD", "psycho-motor development among children with ASD", "effects of motor/physical activities on sensory processing among children with ASD". Inclusion criteria concerned articles published in the last 15 years, in English only, while exclusion criteria referred to articles duplicated in different databases.

The article is structured in several parts. The first part is one of conceptual delimitation, being succinctly presented both the autistic spectrum disorder, but also sensory processing in children with ASD, with reference to sensory integration therapy. The second part aims to present psychomotor development features of children with ASD, identifying the positive influences of practicing motor and sports activities on sensory processing. The article ends by formulating some conclusions and some limitations.

Results

Conceptual delimitations

Several disorders are grouped together in the category of neurodevelopmental disorders. Thus, individuals may be diagnosed with autism, attention deficit and hyperactivity disorder (ADD and ADHD), language development disorders, mental and/or learning disabilities, developmental coordination disorder. These disorders can generate different diagnoses in the area of mental health, individuals can suffer from mood changes, stress, eating disorders, sleep disorders, anxiety, depression, etc. (Male et al., 2023; Muneer & Sultana, 2019).

The deficits of children with ASD, but also with ADHD, target cognitive functions, disturbances in social interactions and repetitive stereotyped behaviors (WHO, 2021). Some children with ASD may have intellectual impairments, which can affect their ability to process, learn, and solve the various situations they encounter. Alteration can refer to the individual's ability to adapt and direct their actions to achieve goals (the executive form

of cognition), as well as to various processes such as attention, memorization, learning, etc. (non-executive form) (DSM-V, 2013). The impairment of cognitive functions is on the spectrum, ranging from profound difficulties in the learning process to average or higher intelligence, where “autistic savants” are included, those who excel in different fields such as mathematics, music, learning foreign languages, etc. This variability of intellectual impairments may determine different degrees of severity in the manifestation of ASD.

Gender is a variable in autism prevalence, with boys being diagnosed more often than girls (3–4 times more common). Early diagnosis and initiation of specialized educational intervention can determine the developmental evolution of the child with ASD. The diagnostic assessment process may be delayed due to the type and severity of the clinical picture of the present symptoms (Male et al., 2023). Not all children with ASD require psychiatric assistance, rather this is considered a specialized educational intervention aimed at training social skills.

Autism spectrum disorder includes different forms of autism, with different degrees of impairment over time in the same child, but also from one child to another, on a scale from mild to severe, with complete or partial clinical picture of the symptoms.

Severe alterations in the area of social interactions and repetitive behaviors, language, as well as intellectual impairments and convulsive episodes are the characteristics of early childhood autism. Children diagnosed with this form have from the first years of life: extreme autistic loneliness, obsessive rigidity when changing routines and contexts that can trigger auto- and/or hetero-aggressive crises, the quasi-absence of language, mechanical memorization not adapted to situations, echolalia, the impossibility of sustaining an authentic communications, hyper-reactivity to different stimuli on different sensory systems (hearing – exaggerated reactions to noises, to different textures of materials and food, to smells, to strong visual stimuli, etc.), automated and repetitive behaviors, lacking spontaneity.

Another less severe form of autism, found after the age of 3, is Asperger's syndrome, which in the clinical picture has symptoms such as: milder speech difficulties, dyslexia, attention deficit hyperactivity disorder (ADHD), average level and above intelligence, disorders in the learning process, rather high level of rigidity when changing routines, under-development of psycho-motor skills, dyspraxia, develops obsessions towards a certain object or theme for which he accumulates knowledge and initiates endless discussions about them, high risk of developing depressive and anxiety disorders in adulthood, sensory disorders with exaggerated reactions to certain strong stimuli. Even though individuals with Asperger's syndrome may have certain disabilities, many of them excel in a field, having exceptional skills (mathematics – memorize numbers, perform mental calculations, memorize texts, events, have spatial memory, musical, artistic skills – drawing, etc.).

The rarest and most severe form of autism is childhood disintegrative disorder (CDD) which manifests itself between the ages of 2 and 4, when cognitive, social and language acquisitions are rapidly lost, with no possibility of recovery, up to the age of two, children apparently developing normally, age-specific. However, until the age of 10, the clinical picture of children diagnosed with CDD includes symptoms such as frequent convulsive episodes, delayed or absent communication skills, especially speech, repetitive and stereotyped behaviors, interests and activities, inability to establish and develop of social relations, initiation and support of interactive and creative games, psycho-motor disorders, control of physiological functions (for example, control of the urinary bladder or bowels).

Most children with ASD, who do not fit the clinical picture of typical autism but have a more severe degree than Asperger's syndrome, can be diagnosed with pervasive developmental disorder, not otherwise specified

(PDD-NOS) or autism atypical. Symptoms are on the spectrum, very different from one child with PDD-NOS, and difficult to diagnose. Symptoms found in this form, with an onset at an older age, include disturbances in the area of social interactions, fewer repetitive stereotypes than in children diagnosed with Asperger's syndrome, superior language skills compared to those found in children with typical autism, but less developed compared to those present in children with Asperger syndrome.

ASD is the result of the action of different factors: genetic (multigenic interactions or spontaneous gene mutations) (Junaid & Pullarkat, 2001), environmental (viral infections, drugs or complications during pregnancy, atmospheric pollutants, etc.) and physiological (dysfunctions in the level of frontal and prefrontal cortex connections and with other parts of the brain) (Bremer et al., 2020; Just et al., 2007; Wass, 2011, quoted by Li et al., 2023).

Sensory processing in children with ASD

Qualitative alterations in the behavioral plan and in the area of communication in the individual with ASD are based on unbalanced processes of information integration – contextual and/or sensory perception. Thus, the context can be perceived differently, fragmented, and the information obtained with the help of the sensory systems is entered into the brain as separate puzzle pieces. Thus, the individual will have difficulties in perceiving the whole and assigning the correct meaning, difficulties in planning and organizing activities, difficulties in understanding his own behavior and that of others. The child with ASD needs more time to process the information received from the sense organs and arrange them into a whole so that they can react adaptively, functionally. The risk of making a mistake in matching the parts is much higher, especially when the amount of information is large. When he/she can no longer manage this processing, the child “explodes”.

Sensory processing disorders are present in a broad spectrum: from differences that represent a mild impairment, to difficulties that appear as a more accentuated form, to dysfunction, the severe form of impairment (Ayres, 2005; Stock Kranowitz, 2022; Oster & Zhou, 2022). The brain of a child with ASD adjusts differently the adaptive, functional reactions to various information received on the 7 sensory systems (proprioceptive, vestibular, visual, tactile, auditory, gustatory, olfactory). The degree of sensitivity determines different behaviors, some of the children being hyper-reactive, others hypo-reactive, while others are looking for sensations to the stimuli received from the environment.

Little et al. (2017) have identified sensory subtypes of behaviors that differ through the interaction of two elements taken from Dunn (2014, quoted by Little et al., 2017): intensity (stimulus detection thresholds – from slow to fast) and self-regulation strategies (from passive to active). These patterns of sensory processing are: registration (high threshold and passive self-regulation) – hypo-reactivity, with a delayed or diminished detection of sensory stimuli; seeking (high threshold and active self-regulation) – includes active engagement in activities or actions that provide intense sensory input; sensitivity (low threshold and passive self-regulation) – hyperreactivity, with an aversion to sensory stimuli; avoidance (low threshold and active self-regulation) – hyperreactivity, with an aversion to sensory stimuli.

Patterns of sensory processing have been associated with activity participation in ASD, internalizing/externalizing behaviors in ADHD, ASD, and typical development and adaptive behavior in ASD (Lane et al., 2010; Kitchin, 2016).

To understand how the co-occurrence of sensory processing patterns affects behavior, research has begun to characterize groups of children based on differences in co-occurring sensory patterns (i.e., sensory subtypes). Lane et al. (2014, quoted by Little et al., 2017) used the short sensory profile to discover the sensory subtypes

of children with ASD. Initially, Lane et al. (2010) identified 3 subtypes: sensory-based inattentive search, motion-sensitive sensory modulation, and taste/odor-sensitive sensory modulation. Later, the same authors (Lane et al., 2010) identified 4 subtypes: adaptive sensory; taste-smell sensitive; postural inattention; generalized sensory difference, whereas Little et al. (2017) identified 5 subtypes: balanced, intense, alert, interested and mild to sensory profiles. The subtypes may reflect variability in all children, not just those with conditions.

Several studies (Schaaf et al., 2011, 2018; Basic et al., 2021) summarize research on the effects that sensory behaviors of people with ASD have on functioning and participation/performance them in her/his activities (Activities of Daily Living/ADLs, play activities, personal care, learning, interaction with family, with others, etc.). Thus, it is estimated that more than 80% of individuals with ASD demonstrate behaviors that may be related to poor sensory modulation, such as self-stimulation (excessive rocking or spinning), avoidance behaviors (such as putting hands over ears in response to typical levels of auditory input), sensory seeking (spinning, chewing, etc.), “withdrawal” behaviors (such as not responding to their name or other environmental cues), attention difficulties (over-reception, under-reception or sensation seeking, combined with a certain degree of persistence, excessive focus and exceptional memory for selective material). Also, difficulties with auditory filtering and sensation seeking in 6–10-year-olds with ASD contribute to poor academic performance and, to a lesser extent, that tactile and auditory sensitivity limits classroom performance.

Lane et al. (2019) conclude that the sensory integration and praxis models of sensory-motor functioning described by Ayres in children with learning and behavioral difficulties are confirmed by advances in neuroscience, with the help of imaging investigations and studies of learning, attention and behavior, making it possible to understand the differential neural functioning that affects their participation and involvement in different activities.

The role of Ayres sensory integration therapy in the intervention program in children with ASD

An intervention program for children with ASD includes several stages (Crăciun et al., 2017). These refer to:

- planning a personalized intervention plan for areas of development (communication, cognitive, autonomy, interaction, motor skills), staged and with the joint effort of the interdisciplinary team (pediatrician, psychiatrist, psychologist, speech therapist, occupational therapist, physical therapist, etc.).
- the choice of different therapies (applied behavioral analysis – Applied Behavioral Analysis/ABA, TEACCH – Treatment and Education of Autistic and Communication Handicapped Children, PECS – Picture Exchange Communication System, HANEN programs, Son-rise, sensory integration therapy, Floor Time, occupational therapies, physical therapy).
- implementing the intervention program in different educational contexts (integrated and/or special system).
- communication relationship with the educators and the correlation of the school program with the one at home.
- compliance with the pharmacological treatment and that of the therapies, the diet.
- coordinating the interventions of the interventional team with the aim of generalizing the behaviors adopted to improve the quality of life of the child with ASD.
- strengthening the child-parent relationship, by educating and training the parents in the attitudinal and behavioral approach towards the child with ASD.

The studies highlight that in order to register progress in the intervention on a person with ASD, several therapies can be used at the same time, in an integrative way, therefore, the joint work of the interdisciplinary team of therapists and parents is necessary (Case-Smith, 2005, 2008; Mastrodinou et al., 2019).

Sensory integration is based on theories of neuroscience, neuropsychology and neurophysiology, which relate to the plasticity and hierarchy of the central nervous system (CNS), brain function, the development of aesthetic integration, the interaction of sensory integration and adaptive behavior, and finally, at the internal level, the motivation of the person to participate in activities with sensory-kinetic experiences (Sianny, 2001, quoted by Mastrodimou et al., 2019).

The concept of sensory integration was developed by Jean Ayres (2005), who argued that it is a neurobiological process, and refers to the administration of sensory stimuli specific to the individual, which processes (CNS), and through this process an adaptive response is produced. Sensory stimuli reaching the brain come from the auditory, optic, vestibular, proprioceptive and tactile systems.

Schaaf et al. (2018) conclude that studies published between 1972 and 2007 suggest that sensory integration interventions help improve outcomes for individualized goals (reading and related skills, sensory-motor skills and motor planning, socialization, behavioral regulation, and attention) over time that, after 2007, they note in the analyzed studies positive results for improving functioning and participation goals of children with ASD, moderate results on improving autistic behaviors and reducing caregiver assistance and emerging but insufficient results related to improving play skills, sensory-motor and language and reduced caregiver assistance with social skills.

Lang et al. (2012) made a synthesis showing the effectiveness or mixed results of sensory therapy in the education and treatment of children with ASD, but at the same time, the lack of benefits, in particular, due to the methodological deficiencies addressed in the analyzed studies.

Sensory integration dysfunction is a disorder in which sensory data is not properly organized in the brain, and this can cause various problems in the individual's development, information processing, and behavior. Thus, stimuli from the vestibular, proprioceptive and tactile systems have a strong effect on the regulatory mechanisms of the nervous system, Ayers' sensory integration uses these senses to facilitate the development of adaptive behavior (Watling & Dietz, 2007).

Ayres concluded that an important role is played by the processing and interpretation of the information received by the child from the environment, with the help of his sensory systems. These brain processes are called "sensory integration." The vestibular system incorporates information received from the inner ear (labyrinth) and detects body movement in space and changes in head position. The tactile system is responsible for coordinating sensory information through touch, giving the ability to feel objects to differentiate them without the use of the visual analyzer. The proprioceptive system includes the sensory information obtained through the musculoskeletal system and provides the individual with the unconscious perception of the location of the body members in space (Willis, 2009; Talay – Ongan & Wood, 2010). Most of the time, the sensory systems work together to send all information to the brain and in turn regulate it. When these cannot cooperate to help regulate the nervous system, the child may experience a sensory integration disorder (Willis, 2009).

Sensory integration therapy (SIT) or sensory processing therapy (SPT) and activities that promote sensory integration are widely used to diagnose and treat disabilities in children with ASD. The treatments based on sensory integration theory that are most often used in working with people with ASD are Sensory Integration Therapy (SIT), Auditory Integration Training (AIT), and Deep Pressure Therapy (DPT) (Green et al., 2006, quoted by Basic et al., 2021).

Sensory integration therapy (SIT) should involve: a) the child's safety; b) opportunities to achieve tactile, vestibular and/or proprioceptive sensory stimulation to support self-regulation, sensory awareness or movement;

c) adequate levels of participant vigilance; d) causing postural, ocular, oral or bilateral motor control; e) new motor behaviors and efforts to organize the movements in time and space; f) preferences in choosing activities and materials; g) activities that are neither too easy nor too difficult; h) activities in which the participant succeeds; i) support for the intrinsic desire to play; j) therapeutic confidence (Parham et al., 2011, quoted by Lang et al., 2012).

The influences of physical and sports activities on the psycho-motor development of children with ASD

Ben Hassen et al. (2023) identified in other studies that 80% of children diagnosed with ASD presented difficulties with coordination and motor skills, deficits in gross and fine motor skills (clumsiness), reduced ankle movement and an abnormal walking pattern (walking top of feet). Furthermore, these children often have impaired static and dynamic postural balance, as a result of defective processing of information coming from the visual, vestibular and proprioceptive systems. For example, in children with ASD, postural instability in the medio-lateral direction in firm/foam surface conditions, both with the eyes open, but especially keeping the eyes closed) (Stins et al., 2015) or in those diagnosed with PDD, a low tactile awareness and an increased proprioceptive input, registering preferences for hard objects and avoiding soft ones (Huri et al., 2014) are found. On the other hand, abnormalities in sensory processing have been detected in 90% of the ASD population showing hypo- or hyper-sensory reactions. Consequently, sensory impairments were included as part of the core definition of autism disorders.

Other investigations prove the association between sensory processing problems and motor impairments in children with ASD starting from the first years of life (Ben Hassen et al., 2023; Purpura et al., 2022). In other words, low performance in sensory processing, and sometimes cognitive skills, can interfere with motor skills, with children with ASD not adapting their motor responses to the environment (time, place and quality), indirectly, negatively influencing their performance in daily activities and social interactions. Therefore, it is necessary to create rehabilitation programs for people with ASD that include both sensory and motor areas, the relationship between them being complex, the neural connections between these regions being affected, resulting in uncoordinated motor responses and altered motor skills.

A synthesis study (Basic et al., 2021) summarizes several studies that have highlighted a series of advances in sensory integration therapy in different areas: motor skills (fine and gross motor skills), communication and interaction skills, occupational performance environment (Kashefimehr et al., 2021); oral and visual-motor skills (Iwanaga et al., 2014; Pfeiffer et al., 2011); nonverbal memory, sequencing, visualization, solving complex problems that require the engagement of certain cognitive and sensorimotor skills (Iwanaga et al., 2014); sensory processing, adaptive behavior, social functioning (Pfeiffer et al., 2011); attention, decrease in self-aggressive behavior in children with ASD (Thompson, 2011).

Also, Basic et al. (2021) identified studies that demonstrated that the use of deep pressure techniques (brushing, massage and squeezing) led to increased calmness (75%), engagement in activities (62.5%), responsiveness to instructions or other environmental stimuli (62.5%), happiness (50%) and communication ability (62.5%) in children with ASD and severe intellectual disability (Brockett, et al., 2014, quoted by Basic et al., 2021). Other authors (Bagatell et al., 2010) reported significant improvements in self-regulation of sitting behavior and participation in learning activities, and in the case of auditory integration training, pre- and post-assessment results indicated an improvement in social awareness, social cognition and social communication (Al-Ayadhi et al., 2013).

Roley et al. (2015) showed that children with ASD experience difficulties in visual praxis (imitation practice, bilateral vestibular integration) but also in somato-praxis, with consequences in their level of participation in activities.

Motor issues are shown in many areas, including functional mobility, physical activity, participation and competence in activities of daily living, and risk of falling (Miller et al., 2024).

Motor and sports activities are included in the therapeutic program of children with ASD, the goals of movement therapy aiming at (re)educating the skills of moving and driving objects (gross and fine motor skills). The exercises and games chosen by the educator/therapist aim at the acquisition of psycho-motor skills (segmental and general coordination, manual dexterity, laterality, spatio-temporal orientation, static and dynamic balance, body schema) with effects on the functioning and motor performance of these children.

Several studies (Arkesteyn et al., 2022; Nacario, 2016; Lee & Hodge, 2017; Carbone et al., 2021; Yu et al., 2018) highlight benefits on physical health of children with ASD: cardiovascular, digestive and cerebral functions (oxygenation and brain development), aerobic capacity and muscle tone, sleep quality and duration.

Other studies attest to positive effects on psycho-social health, improving the quality of life (Muneer & Sultana, 2019; Jia et al., 2023; Ferreira et al., 2018; Alhowikan, 2016). The motor, socio-affective, cognitive and interpersonal skills learned during movement therapy programs are transferred to other contexts, contributing positively to managing these new/other situations. In addition, aggressive and self-aggressive behaviors, self-stimulation, hyperkineticism and stereotypies decreased as a result of the introduction of program of moderate intensity physical exercise of 30 minutes twice a week for 48 weeks (Toscano et al., 2022), kata training techniques 4 times a week for 14 weeks (Bahrami et al., 2012), swimming (technical and games-based forms) for 8 weeks (Marzouki et al., 2022; Pimenta et al., 2016), horse-riding (García-Gómez et al., 2014).

Regular programs of motor activities and sports create routines in children with ASD, which leads to an improvement in well-being, self-control of emotions in interactive contexts, reduce the level of anxiety, depression, self-isolation (Yu et al., 2018; Zhao & Chen, 2018; Randell et al., 2022). In addition, there are studies that show positive effects from a social point of view (establishing and maintaining relationships, acceptance by others, etc.) on children and adolescents with ASD who followed various motor activities, exercises and games in small group sessions (2 to 5 people) and swimming over 8–12 weeks (Zhao & Chen, 2018; Kocak et al., 2021; Jia et al., 2023).

Several studies report a lower or delayed level of gross and fine motor development in children diagnosed with mild and moderate forms of ASD (Muneer & Sultana, 2019; Kashefimehr et al., 2021; Roley et al., 2015; Miller et al., 2024; Sorensen & Zarrett, 2014; Wang et al., 2022; Roşca et al., 2022; Hunt et al., 2023; Abdel Ghafar et al., 2022; Gal et al., 2007; Phytanza et al., 2023; Lourenço et al., 2020), even those with varying degrees of intellectual disability (Gkotzia et al., 2017). Thus, psychomotor skills such as balance (including body posture, control of body movements, but also dynamic balance), general and eye-motor coordination, manual dexterity, muscle tone, movement skills (walking, running, jumping, crossing obstacles) are affected, climbing, crawling) and handling the object (throwing, catching, hitting and kicking, rolling and passing of the ball etc.). Moreover, the sensory-motor functions are also underdeveloped, the sense organs of children with ASD taking in an inappropriate and non-functional way the information from the environment, the behavioral reactions being hyper-reactivity, hypo-reactivity or sensation seeking. The relationship between the level of development of motor skills and social skills is proven, with the association being stronger with fine skills than with gross skills. Manual dexterity among fine motor skills and the ability to control objects among gross motor skills are the most strongly associated with social skills (Ohara et al., 2019).

On the other hand, executive and non-executive cognitive function is positively influenced by the practice of motor and sports activities in children with ASD, with benefits on academic and behavioral performance (Pan et al.,

2017; Milajerdi et al., 2021; Li et al., 2023). Attention, memory, adaptability, inhibitory control of body movements are positively influenced by practicing different types of physical and sports activities: swimming, horse riding, yoga, martial arts, light running and stationary cycling, etc. (Bass et al., 2009; Ward et al. 2013; Tan et al., 2016; Hassani et al., 2020a; Srinivasan et al., 2014; Hassani et al., 2020b; Rech et al., 2022). However, the degree of impairment due to autism, which is associated with a higher risk of comorbidities, is not a predictor of participation in physical activities (Arkesteyn et al., 2022).

The content of motor and sports activity programs is individualized, being adapted by educators/therapists according to each individual, his/her needs and interests, the level of development of psycho-motor and social skills. The goals of therapeutic programs are most often achieved in individual therapeutic sessions. Personalized adaptation, avoiding the feeling of not being understood by the child with ASD by others, the unpredictability of others' actions is considered advantages of individual therapy (Sowa & Meulenbroek, 2012). To the extent that the child acquires knowledge and skills, gets used to the structure of physical exercises and games, activities with another child of the appropriate level can be introduced, the development of communication, awareness of the other's presence and collaboration in carrying out the common task (work in team) making up the objectives of the pair meetings. It is proven that motor and sports activities in groups can also be carried out successfully (Breedved et al., 2010; Lox et al., 2010; Walker et al., 2010, quoted by Sowa & Meulenbroek, 2012).

Conclusions

ASD is a neurodevelopmental disorder characterized by deficits in behavior and communication and social interaction of the person diagnosed, with negative consequences on functioning and performance in different areas. With different forms of manifestation and degrees of impairment, the individual with ASD presents difficulties in contextual and/or sensory perception of stimuli, which causes maladaptive responses from him/her. Sensory processing models and subpatterns are tools to understand the mechanisms, factors that determine differences in functioning and participation in activities (ADLs, play, learning, interaction with others).

Intervention measures for children with ASD aim at an integrated effort of an interdisciplinary team of therapists alongside parents. Along with other therapies, sensory integration therapy, developed by Ayres, is beneficial in treating and educating the child with ASD who uses their senses to facilitate the development of adaptive behavior (stimuli from the vestibular, proprioceptive, and tactile systems have a strong effect on regulatory mechanisms of the nervous system).

Scientific evidence shows that more than 80% of children diagnosed with ASD have deficits in the motor area (gross and fine motor skills, abnormal walking pattern, reduced ankle mobility, coordination, postural and dynamic balance, etc.). In addition, there are associations between sensory processing difficulties and motor impairments, even from the first years of life, with the motor and sensory areas being in neural connection and developing at the same time at an accelerated rate.

Motor and sports activities have positive effects on children with ASD, proven by scientific studies, the influences being shown in different areas: physical health (maintains/reduces the weight index, improves cardiovascular function, increases muscle tone, regulates certain internal functions, oxygenation of the brain, improves sleep in terms of duration and quality), mental health (reduces anxiety and depression, well-being, self-control of emotions, reduces/avoids social isolation, etc.), motor functions (oral and visual, gross motor skills and fine, manual dexterity, balance, ability to relax and control body movements), sensory processing, cognitive processes

(memorization, sequencing, attention, cognitive flexibility, inhibitory control of body movements, academic performance), communication and social interaction skills (establishing and maintaining friendships, acceptance from others), decrease in stereotyped and self-aggressive behaviors, self-stimulation, hyperkinetic behavior.

A number of limitations of this study are identified. Thus, the database search area was relatively limited, considering only the most well-known databases. Expanding the search area may provide opportunities to identify other current bibliographic sources. The search involved the formulation of several phrases that included both autism spectrum disorder, sensory processing in the case of ASD, motor/physical and sports activities in children with ASD, the benefits of these activities as occupational therapy activities included in the therapeutic programs of children with ASD. Expanding the search, by formulating more varied phrases, can also expand the area of coverage and systematization of influences.

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