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Adapted Riding Intervention Programs in Individuals with Autism Spectrum Disorder: A Scoping Review

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Abstract

Adapted riding has proven to be a successful sports intervention, yielding significant functional, social, educational, and therapeutic outcomes. Adapted riding offers tailored horsemanship experiences for participants, including those with autism spectrum disorder. Individuals with autism spectrum disorder appear to have motor difficulties based on standard motor assessments. It is also possible for them to present difficulties in executing standard motor tasks based on their age group. In addition, they experience challenges in controlling their posture, planning motor sequences, and mimicking movements, potentially hindering their ability to achieve age-appropriate motor milestones. The purpose of the study was to explore the possible benefits of adapted riding in individuals with autism spectrum disorder. For this purpose, a scoping review was performed. A total of 14 studies of recent years were examined. The age range was between 2 and 19 years, and the intervention programs lasted approximately 4 to 30 weeks. Results showed positive effects on motor, social, and behavioral areas, along with enhanced communication skills, ultimately leading to a better quality of life for this population. Notably, these programs resulted in advancements across several quality-of-life areas, such as reduced aggression and improved communication. Positive effects were also found on sensory seeking, sensory sensitivity, and focus, leading to less distraction and sedentary behaviors. Adapted Riding also had a positive impact on postural control, increased stability, and encouraged more participation in leisure activities. In conclusion, adapted riding is characterized as a valuable rehabilitative, educational, therapeutic and athletic method for individuals with autism spectrum disorder.

Keywords: Human-Animal Interaction, Animal-Assisted Intervention, Therapeutic Riding, Disability, Autism Spectrum Disorder.

1. INTRODUCTION

Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by social communication deficits, repetitive behaviors, and challenges in self-perception, learning, and adapting to daily situations (American Psychiatric Association, 2013). Those with ASD frequently experience challenges in communication, socializing, and engaging in repetitive behaviors, affecting their functioning in various areas. There's been a significant increase in ASD diagnoses in recent years, with an estimated 1 in 44 children in the US diagnosed with ASD by age 8 in 2018. This diagnosis is more frequently observed in boys (Maenner *et al*., 2021). Diagnosis takes place during childhood through the appearance of certain symptoms, such as lack of social interaction, communication delay, limited interests and stereotypical movements.

DSM-V (Diagnostic and Statistical Manual, 5th Edition, 2013) outlines three levels of severity for ASD diagnoses.

Level 3: requires a high level of assistance. Severe impairments in functioning can occur due to significant difficulties with both verbal and nonverbal communication in social settings.

Level 2: demanding substantial aid. Deficits in verbal and nonverbal social communication skills contribute to social impairments.

Level 1: requiring support. Concerning social communication, there are deficits that can cause impairments. There is decreased interest in social interactions.

Individuals with ASD appear to have motor difficulties based on standard motor assessments. It is also possible for them to present difficulties in executing standard motor tasks based on their age group (Moraes *et al*., 2017). In addition, they experience challenges in controlling their posture, planning motor sequences, and mimicking movements, potentially hindering their ability to achieve age-appropriate motor milestones (Downey & Rapport, 2012). Motor skill limitations, like poor coordination and balance, greatly restrict their options for physical activities. Additionally, children with ASD may struggle with gross motor skills like poor visual-motor coordination, bilateral coordination, posture, and balance, both static and dynamic (Bhat, Landa & Galloway, 2011; The inability to execute complex motor tasks may lead to preferences relating to sedentary leisure activities, such as watching television or the use of a computer. At the same time, social difficulties relating mainly to communication make their participation in team sports and the creation of relationships difficult (Srinivasan, Pescatello & Bhat, 2014).

Individuals with ASD are part of a complex multisystem of disorders characterized by multiple disorders in many areas (Srinivasan *et al*., 2014). Regarding sensory disorders, they may present difficulties in tactility, hearing, vision, and the vestibule system with rapid or slow response to sensory stimulation. Many individuals with ASD appear comorbidities, such as gastrointestinal disorders and dietary restrictions. Furthermore 90% of them experience variations in the process of sensory situations, such as hypersensitivity in touch and other sensory-related disorders that may limit their ability to fully engage in motor activities and other tasks typically required for learning, especially in relation to their age group (Robertson & Baron-Cohen, 2017; Schauder & Bennetto, 2016). To support the development of new motor skills, individuals with ASD may benefit from targeted strategies and interventions designed to enhance motor control, improve motor learning techniques, and build overall motor skills (Djordjevic, Memisevic, Potic & Djuric, 2022; Ruggeri, Dancel, Johnson & Sargent, 2020). Adapted Riding (AR) intervention programs offer opportunities for activity participation and communication, which can positively impact the social impairments commonly seen in individuals with ASD. As a result, these interventions have the potential to enhance the overall quality of life for individuals with ASD (Date, Munn & Frey, 2024).

Adapted Riding

The interaction of individuals with animals may significantly enhance their psychosocial well-being. The documented benefits of adapted riding (AR) interventions include reduced stress, lower heart rate and blood pressure, diminished feelings of loneliness and isolation, and improved social interaction and socio-emotional functioning (Friedmann & Son, 2009). The incorporation of animals in therapeutic activities is known as animal-assisted intervention (AAI), which encompasses both animal-assisted therapy and animal-assisted activities. AAI started around the end of the 18th century, where patients interacted with animals in mental institutions to improve their social skills. Today, the implementation of animal-assisted therapy has been linked to positive outcomes for individuals with ASD, as they can benefit from participating in animal-assisted therapeutic activities (O'Haire, 2013).

AR is applied by specialists in sports science, kinesiology, physical and occupational therapy and is considered as a valuable tool when engaging with the therapy of developmental disorders within the ASD. Due to the unique relationship that is developed among the individual, the horse, and the trainer, AR is characterized as a widely recognized method for rehabilitation and teaching therapeutic tool for individuals with ASD (O'Haire, 2013). Incorporating animals into the treatment process to reduce problem behaviors and improve functioning has been identified as a promising intervention approach for individuals with ASD (Esposito *et al*., 2011; Gabriels *et al*., 2015).

Therefore AR is mentioned for the use of horses in activities aiming to the achievement of many therapeutic goals relating to physical and mental benefits as well as socio-cognitive, behavioral, and educational goals. Beyond recreational therapeutic activities (e.g. learning horseback riding skills), AR is based on the development of a relationship between the animal and the rider. Additionally, AR intervention programs positively influence participants' intentions to engage in activities with the horses, and therefore there are benefits in motor skills, sensory system function, social and communication skills (Hariri *et al*., 2022). Consequently, it is possible that this alternative therapy provides a multisensory environment that may prove beneficial to them (Bass, Duchowny & Llabre, 2009). Intervention programs are individualized therapies with the trainer holding the basic role. It provides significant support in therapy of developmental disorders within the ASD. Due to the unique relationship that develops among the individual, the horse, and the trainer, AR is characterized as one of the most recognizable methods of rehabilitation, education, therapy, and sport for individuals with ASD with profound motor, social and communication benefits (Lessick *et al*., 2024).

Based on the previous discussion, the primary aim of this study was to systematically examine and review research on AR intervention programs for individuals with ASD. The findings from this study are expected to provide a comprehensive literature review on

the outcomes and benefits of these interventions, specifically in enhancing social, communication, behavioral, motor, functional, and sensory skills in individuals with ASD.

2. METHODS

Articles that met the following criteria were selected for the review: a) Published in English; b) Published between 2009 to 2024; c) Participants limited to individuals with disabilities and especially individuals with the ASD according to DSM-V (2013) and AR intervention programs; d) The age range of participants should be from 2 to 19 years; e) The duration of intervention programs should be from 4 to 30 weeks; f) AR should be offered by specialists in Sports Science, Kinesiology, Physical and Occupational Therapy. Person, concept, and context (PCC), as recommended by Peters *et al.,* (2015), was used to structure the inclusion criteria as follows: person-developmental disability (ASD); concept-AR intervention programs; and context-individuals with disabilities; English language. The inclusion and exclusion criteria were used to refine search strategies and provided a framework for searching the literature (Table 1). A scoping review of AR intervention programs and individuals with ASD research showed constant growth over recent years and positive progress towards inclusion of AR intervention programs in individuals with disabilities. The purpose of conducting this scoping review was to identify and map the existing evidence (Arksey & O'Malley, 2005). The framework followed for this scoping study included the following stages: Stage 1: identifying the research question, Stage 2: identifying relevant studies, Stage 3: study selection, Stage 4: charting the data, Stage 5: collating, summarizing, and reporting results (Arksey & O'Malley, 2005).

Stage 1

The aim of this scoping review was to examine the effects of AR in individuals with ASD, with a focus on key characteristics that determine whether AR intervention programs can enhance social, motor, operational, and sensory skills.

The research question addressed in this study was:

- What does the existing literature reveal regarding the effectiveness of AR intervention programs in individuals with ASD?

Stage 2

A review of the literature dated the first semester of 2024 was done. Research took place on main data sources and research engines (Google Scholar and PubMed) to gather all relevant articles. The selection process focused on AR for children and adolescents with ASD. Various key words were used such as AR, therapeutic horseback riding, individuals with disabilities, and ASD. From the research, we excluded studies that were implemented prior to 2009 or included in their sample adults with ASD older than 19 years old, as well as studies with duration shorter than 4 weeks since they did not comply with the aim of the present study.

Stage 3

This process resulted in the selection of 14 out of the 40 articles that were studied in order to investigate the effect of their results on the present study (Table 2).

Stage 4

The charted data were entered into a 'data charting form' using the Excel database program. The following information was recorded: 1) Title, 2) Author(s), and year of publication, 3) Intervention type and duration, 4) Study population, 5) Aims of the study, 6) Methodology, 7) Outcome measures and 8) Key results.

Stage 5

We recorded and summarized the key characteristics of all studies, including details such as intervention programs, sample sizes, participants, research methods, outcomes, and evidence of effectiveness.

3. RESULTS

All 14 selected studies were published within the last 15 years (2009-2024), indicating the implementation of AR intervention programs in individuals with ASD. The inclusion and exclusion criteria are summarized in Table 1. Details are described as follows.

Table 1: Inclusion and exclusion criteria for a scoping review regarding studies on AR Intervention Programs for individuals with ASD

Criterion	Inclusion	Exclusion
Language	Published in the English language	Non English articles
Time period	January 2009-November 2024	Articles published outside this time frame
Population focus	Children and adolescents up to 19 years old experiencing a specific type of disability (e.g.) developmental disability (ASD)	Adults with ASD older than 19 years old Individuals experiencing other disability (e.g. mental disorders, depression, stroke, rehabilitation, special educational needs, motor disorders, visual and hearing impairments, intellectual disabilities, cerebral palsy) and individuals without disabilities

Study focus	AR intervention programs	Studies not primarily focused on AR or animal-assisted interventions
Literature focus	Studies that used AR intervention programs in individuals with ASD to export outcomes and benefits	Review articles including narrative reviews, rapid reviews, critical reviews, integrative reviews, and the gray literature such as blogs, commercial Web sites, opinion articles, commentaries, and information sites

Participants and Sample

The included studies were conducted in the following countries: two in Spain (Gomez *et al*., 2014; Vilarroig *et al*., 2024), ten in the United States of America (Ajzenman *et al*., 2013; Bass *et al*., 2009; Fillmore *et al*., 2019; Holm *et al*., 2014; Gabriels *et al*., 2015; Gabriels *et al*., 2018; Jenkins *et al*., 2013; Nelson *et al*., 2011; Steiner *et al*., 2015; Ward *et al*., 2013), one in Iran (Ghorban *et al*., 2013) and one in China (Zhao *et al*., 2021).

The age of the participants in the included studies ranged from 2 to 19 years. In all studies, the population consisted of children and adolescents with ASD.

Outcomes

The analysis of the studies identified two basic outcomes. Table 2 provides details of the outcomes of AR intervention programs in individuals with ASD.

Social, Communication, and Behavioral Skills Outcomes

There is no doubt that AR intervention programs lead to significant improvements in the social, communication, and behavioral skills of individuals with ASD. Ten studies have demonstrated the positive impact of these programs on individuals with ASD, revealing considerable benefits.

Bass *et al*., (2009) examined the effect of AR on the social skills of individuals with ASD. Participants in the experimental group received AR sessions lasting one hour per week over a period of 12 weeks. During all sessions, participants received positive feedback after each session while trainers tried to keep constant eye contact with them. Results indicated that individuals with ASD showed increased sensory seeking, sensory sensitivity and social motivation, along with reduced inattention, distractibility, and sedentary behaviors. Furthermore, Fillmore *et al*., (2019) examined whether social skills and sensory operation were improved following an 8-week AR intervention program for children with ASD. Results revealed that participant's involvement with AR improved their social skills. Nevertheless, researchers mentioned that more studies with larger samples and longer duration are needed to acquire more enhanced data.

In this regard, Gabriels *et al*., (2015) evaluated the effectiveness of AR on self-regulation, socialization, communication, adaptive behaviors, and motor skills in children with ASD. The intervention group demonstrated improvements in irritability, hyperactivity, social and cognitive skills, as well as the ability to say new words. The results were consistent with previous studies on children with ASD, demonstrating that interactions between individuals and horses can lead to positive behavioral changes.

In their study, Gabriels *et al*., (2018) presented 6-month follow-up data for participants with ASD who had taken part in a previously published controlled trial of AR, compared to a no-horse contact active control group. They examined whether the significant improvements in irritability, hyperactivity, and social and communication behaviors observed in participants who received a 10-week manual-based intervention were maintained 6 months after the intervention ended. Comparisons between baseline and the 6-month follow-up revealed that participants sustained the significant initial improvements in social and communication behaviors.

The acquisition of social skills contributes children and adolescents with ASD to create friendships, develop interests and hobbies, learn through the observation of others' behaviors, demonstrate empathy, and improve both their quality of life and psychological health. Specifically, Ghorban *et al*., (2013) examined the benefits of AR on the social skills of children with ASD. Results showed that the mean score of social skills was higher than the initial measurements, as were the understanding of their feelings, their decisiveness, and their interaction with other individuals. Consequently, AR in children with ASD may improve all areas of their social skills.

According to Holm *et al*., (2014), who investigated the impact of three different frequencies of AR [one time/week as control dose, three times/week, and five times/week) on parent-identified target behaviors of three participants with ASD, changes in behavior were observed during the sessions and assessed for any carryover into the home and community settings. Compared to baseline, results showed that 70% of the targeted behaviors, improved during the intervention, with 63% of these improvements being retained during withdrawal phase. Parents reported positive outcomes in physical core strength and coordination, including an improved ability to sit upright on the horse for a longer portion of the session, better control of the reins, and enhanced ability to stand in the stirrups.

It is certain that AR has a positive effect on the physical, mental, educational and social levels for

children of various ages with ASD. In this regard, Gómez *et al*., (2014) studied the social and behavioral effects of a program of an introductory horseback riding and AR program in a group of ASD pupils. Results indicated significant differences of the AR program only on the participant's aggressive behavior and no differences on social interaction.

The purpose of the study of Nelson *et al*., (2011) was to assess the results of AR intervention programs on social and functional behavior in young children with ASD. Overall, results indicated some evidence that AR can be beneficial to individuals with ASD. Because one out of three participants developed deviant behavior during the first days, probably out of fear of the horse, a specially adapted desensitization program was followed. For the two participants who followed the initial program, measurements showed that during the whole duration of the intervention, their social and deviant behavior were not stable but altered depending on the day. On the contrary, participants that followed the desensitization program showed almost zero deviant behaviors and increased verbal and non-verbal behavior.

According to Ward *et al*., (2013), the correlation between AR, social communication, and sensory processing skills was studied. The aim of the study was to investigate whether children with ASD would retain the results of therapy following the end of the intervention. Results indicated that participants showed improvements on their social interaction and sensory perception while the severity of symptoms relating to ASD was reduced. Nevertheless, those benefits were not retained after six weeks of absence from AR but were reinstated right after their return to the program.

In this regard, Zhao *et al.*, (2021) examined the results of a 16-week AR program regarding the social interaction and communication skills of children with ASD. Results indicated a positive effect on both social skills and communication. Significant differences were observed in social interaction during and after therapy. Improvements were observed in six out of seven areas of communication, while feelings of responsibility and self-control increased.

In conclusion, individual's participation in AR programs revealed benefits upon social behaviors and social communication. Improvements in social interaction and communication skills were likely due to the opportunities for verbal and nonverbal interactions with horses, peers, and trainers. These interactions provided individuals with ASD the possibility to better understand others, thereby potentially enhancing their social and communication skills (Chen *et al*., 2022).

Motor Skills Outcomes

It is widely recognized that AR in individuals with ASD has been proven to improve balance, strength, motor coordination, sensory function, and social skills since individuals often create emotional bonds with the horses they ride. Four studies reported benefits from the participation of individuals with ASD in AR intervention programs. Ajzenman *et al*., (2013) specified whether AR may increase functional skills and willingness to participate in activities for children with ASD. Results indicated that through AR, instability and body sway were significantly reduced. Significant improvements were also noted in general adaptive behaviors (receptive communication and treatment), self-care, social interactions, and the increase of motivation for participating in leisure activities. In conclusion, results showed that AR had a positive effect on children with ASD and may be a useful therapy tool for this population.

In this regard, Jenkins *et al*., (2013) evaluated the effect of AR on the behavior of children with ASD. Participants engaged in a 60-minute program over nine weeks. Before the first session, preparatory lessons were conducted to assess each rider's skill level and establish goals. Results showed that the participation in the program did not lead to significant changes in happiness and sadness, response and spontaneity during the initial phase, compliance, behaviors at home, behavioral problems, or overall performance. However, three out of four participants, showed improvement in their body posture.

According to Steiner *et al*., (2015), AR benefits were investigated in the development of children with ASD. Experiments were conducted to analyze walking and assess motor coordination to observe any alterations. Results revealed significant differences before and after therapy, revealing a much more stable walking cycle on the sagittal plane. Therefore, researchers concluded that AR may be a successful supplementary therapy for children with ASD, particularly in cases where other therapies have not been effective.

The aim of the study by Vilarroig *et al*., (2024) was to investigate the impact of an AR program on the postural control of children with ASD. Participants took part in a specific AR program, consisting of 45 minute sessions/per week, over the course of three months. The results showed that this horse-based intervention had a positive effect on the postural control of children with ASD.

Table 2: Overview of main characteristics of the selected studies regarding AR intervention programs in individuals with ASD

Author(s)	Participants	Instruments	Outcomes
Ajzenman *et al.*, (2013)	6 ASD (ages from 5 to 12 years)	Vineland Adaptive Behavior Scales–II, Child Activity Card Sort	Reduction of instability and postural sway, improvement of general adaptive behaviors, improvement of self-care and social interactions.
Bass *et al*., (2009)	34 ASD (ages from 4 to 10 years)	SRS Social Responsiveness Scale SP, or Sensory Profile	Improvement of sensory search, sensory sensitivity, social motivation, better focus, less distraction, and sedentary behavior.
Fillmore *et al*., (2019)	7 ASD (ages from 6 to 19 years)	Social Responsiveness Scale, or SRS, Sensory Profile Survey, or SPS	Improvement of social skills.
Gabriels *et al*., (2015)	127 ASD (ages from 6 to 16 years)	Social Communication Questionnaire (SCQ) Autism Diagnostic Observation Schedule (ADOS) or ADOS-second edition (ADOS-2) Aberrant Behavior Checklist-Community (ABC-C)	Improvement of excitability, hyperactivity, social and cognitive skills, and saying new words.
Gabriels *et al*., (2018)	64 ASD (ages from 6 to 16 years)	Aberrant Behavior Checklist-Community (ABC-C), Social Responsiveness Scale (SRS) Systematic Analysis of Language Transcripts (SALT)	Maintenance of high levels of excitability after 6 months. Maintenance of social relations and communication at the same levels as 6 months before.
Ghorban *et al*., (2013)	6 ASD (ages from 6 to 12 years)	Social Skills Rating System (SSRS)	The mean score of social skills of children with ASD was higher than the initial measurement as was the understanding of their feelings, decisiveness, starting and maintaining their interaction with other individuals.
Gómez *et al*., (2014)	16 ASD (ages from 7 to 16 years)	Behavior Assessment System for Children" (BASC) Quality of life Questionnaire	Significant differences in some of the quality-of-life indicators and lower levels of aggressiveness (BASC)
Holm *et al*., (2014)	3 ASD (ages from 6 to 8 years)	Social Responsiveness Scale (SRS) Sensory Profile-Caregiver Questionnaire (SP-CQ)	Compared to baseline, 70% of the target behaviors were better during intervention and improvement was retained in 63% of the behaviors during withdrawal.
Jenkins *et al*., (2013)	7 ASD (ages from 6 to 14 years)	The Child Behavior Checklist (CBCL/6–18 Assessment forms that measure ability, adaptive operation, problems in externalization and internalization, and syndromes.	AR did not cause systematic alterations to the feelings of happiness and sadness, to the answers and spontaneity during the start phase, compliance, behaviors at home, behavioral problems, and performance.
Nelson *et al*., (2011)	3 ASD (ages from 2 to 4 years)	Video Tapes, 6 seconds recording system, Single-case reversal designs	Instability of social and deviant behavior of the two participants who followed the entire program. Almost zero level of deviant behavior and increase of verbal and non-verbal models for the individual that followed the desensitization program.
Steiner *et al.*, (2015)	26 ASD (ages from 10 to 13 years)	Pedagogical Analysis and Curriculum (PAC) test, Instruments for the analysis of the walking cycle	Stabilization of the walking cycle on the sagittal plane.
Vilarroig, *et al.*, (2024)	9 ASD	Postural control with T-plate (posturographic platform)	Positive effects on the postural control

	(ages from 9 to 12 years)	(evaluation of the area covered by the centre of pressure)	
Ward *et al*., (2013)	21 ASD (mean age 8.1 years)	Gilliam Autism Rating Scale: Second Edition GARS-2, Sensory Profile School Companion SPSC	Significant increase in social interaction, improvement in sensory perception, reduction of the severity of symptoms related to ASD.
Zhao *et al*., (2021)	61 ASD (ages from 6 to 12 years)	Social Skills Improvement System Rating Scales, SSIS-RS Assessment of Basic Language and Learning Skills-Revised (ABLLS-R)	Improvement of the total social-communication skills during therapy and afterwards.

4. DISCUSSION

It is widely known that AR is an intervention method with many significant benefits for individuals with disabilities. The aim of the present study was to investigate all benefits of the AR intervention programs for individuals with ASD. A scoping review took place on a total of 14 studies. Participants were children and adolescents, ages 2-19, with the duration of the intervention programs being 4 to 30 weeks. Results indicated that AR intervention programs significantly contribute to the reduction of symptoms found in individuals with ASD.

More specifically, programs revealed improvements in various aspects areas of quality of life, including reduced levels of aggressive behavior (Gómez *et al*., 2014), and enhanced abilities in communication, such as accepting, understanding, and expressing oneself. Social skills (Fillmore *et al*., 2019), social interaction, understanding of feelings, decisiveness, and interaction with others (Ghorban *et al.,* 2013) also improved. Additionally, positive effects were found on sensory seeking, sensory sensitivity, and focus, with reductions in distraction and sedentary behaviors (Bass *et al*., 2009). Hyperactivity, excitability, cognitive skills, and saying new words were also improved (Gabriels *et al*., 2015). While AR did not lead to systematic changes in feelings of joy and discontent, response and spontaneity, compliance, behaviors at home, behavioral problems, and performance, some participants did show improvements in body posture (Jenkins *et al*., 2013). Communication skills were enhanced with increased feelings of responsibility and self-control (Zhao *et al*., 2021). Furthermore, AR resulted in a stabilization of the walking cycle on the sagittal plane (Steiner *et al*., 2015), positive effect on postural control (Jenkins *et al*., 2013; Vilarroig, *et al*., 2024), increased stability, as well as greater motivation for participation in leisure activities (Ajzenman *et al*., 2013).

The review of the studies showed that more sessions per week increased the positive effect produced during the session, at home and in society (Holm *et al*., 2014). It was also observed that high levels of excitability were maintained even after six months of absence from AR programs, but previous levels of hyperactivity returned to where they were prior to their participation to the program (Gabriels *et al*., 2018). According to Ward *et al*., (2013), results indicated a significant increase in social interaction, improvement of sensory understanding, and reduction of the severity of symptoms related to ASD. These benefits did not last past the six-week temporary pause from the program but were reinstated as soon as the individuals began their participation to the program. Therefore intervention programs should be reformed and adjust according to the needs of the participants. In the study of Nelson *et al*., (2011), participants showed almost zero deviant behaviors and increased verbal and non-verbal behavior.

Regarding the effects of AR interventions programs, results indicated that individual's participation revealed benefits in social behavior and communication. These improvements are likely attributed to the opportunities individual's gained from their interaction with horses, peers, and trainers. Such interactions may have contributed to enhanced social and communication skills (Chen *et al*., 2022).

Consequently the intervention method with the assistance of the horse may constitute an effective tool for education, rehabilitation and sport participation for individuals with ASD. Therefore AR intervention programs contribute to improving the postural control of individuals and specifically balance ability, since it is an activity that involves coordinating multiple stimuli from different sensory channels (Hameury *et al*., 2010). Moreover, it is considered an intensive exercise for improving balance. The horse's gait induces continuous changes in the rider's center of gravity, requiring immediate positional adjustments to avoid falling off (Lasa *et al*., 2015; Tseng *et al*., 2013). Additionally, it is a motivating and highly structured activity that encourages participants to engage with horse-related tasks (Gómez *et al*., 2014; Vilarroig *et al*., 2024). As a result, these interventions have the potential to improve the overall quality of life for individuals with ASD (Date *et al*., 2024).

5. CONCLUSIONS

In conclusion, this scoping review aimed to examine the benefits of AR intervention programs in individuals with ASD. Findings and implications indicated that individuals who participated in AR intervention programs experienced significant improvements in their social behavior and

communication as a result of their connection with the horses. It is well-established fact that horses are social beings and display a keen awareness of human reactions. Interacting with horses has been found to positively impact individuals with ASD behavior, resulting in enhanced social understanding and improved communication skills.

In addition, most studies revealed benefits to the postural control of the participants. These improvements likely occurred due to the highly structured and motivating context, which provides intense and specific multisensory stimulation tailored to the participants individual needs. This activity is particularly well-suited to the characteristics of individuals with ASD, as it is based on individual participation while also incorporating multiple interactions in a more structured setting than other team sports.

The effectiveness of these interventions for individuals with ASD may be attributed to their specific nature. In AR intervention programs, interactions are structured, goal-directed, progressive, and interconnected. Their effects result from a sequence of training steps and a range of stimuli. Those with ASD rely on verbal and non-verbal communication to guide their horses. Active engagement and focus are essential for carrying out all of the processes. Participants in an AR intervention program can connect and engage with horses. Furthermore, these programs provide an alternative intervention method that utilizes the interaction between horses, individuals with ASD, and riding instructors to promote meaningful engagement in leisure activities that target the core impairments of the participants.

The success of these AR intervention programs varies, highlighting future research to determine the most effective programs for various conditions and age groups. It is important to assess the relevance and feasibility of different techniques. Additionally, further exploration is needed into the intensity, duration, and long-lasting effects of the sessions.

Conflict of Interest: The authors declare no conflict of interest.

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