Effectiveness of Virtual Reality (VR) in Improving Social Skills in Autism Spectrum Disorder Cases: A Literature Review

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Abstract. This literature review examines the effectiveness of virtual reality (VR) in improving social skills in individuals with Autism Spectrum Disorder (ASD). Autism Spectrum Disorder (ASD) is a neurobiological developmental disorder characterized by barriers to social interaction, communication, and limited or stereotyped interests. Virtual Reality (VR) Intervention based on occupational therapy has become the focus of research in efforts to improve social skills in individuals with ASD. The purpose of this review is to assess the current state of research and provide an overview of the findings regarding the effectiveness of VR interventions in enhancing social skills in individuals with ASD. From the search results through various databases, 315 articles were found which were then filtered based on inclusion-exclusion criteria to obtain 5 articles. 5 articles without duplication were then carried out Critical Appraisal and the final result after selection was 5 articles. The review reveals that VR interventions show promise in improving social skills, including social interaction abilities, emotion understanding, and communication skills, in individuals with ASD. The findings suggest that VR has the potential to be an effective tool for enhancing social skills in individuals with ASD. However, further research is needed to validate and deepen our understanding of the effectiveness and underlying mechanisms of VR interventions in this population.

Keywords: Autism Spectrum Disorder, Occupational Therapy, Virtual Reality, Social Skills, Intervention.

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1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by deficiencies in social communication and social interaction in various contexts, including non-verbal communication behaviors used for social interaction and skills for developing, maintaining and understanding social relationships. (APA, 2013). According to the Autism and Developmental Disabilities Monitoring (ADDM) Network funded by the Center for Disease Control and Prevention (CDC) around 1 in 36 children has been identified as having autism spectrum disorder (ASD) in 2020. The prevalence of ASD continues to increase and is a major public health problem which need to be addressed immediately. One of the hallmarks of children with ASD is their inability to participate in normal social interactions. Children with ASD can experience severe deficits in verbal and nonverbal social skills, have difficulty initiating social interactions, and rarely provide feedback in their interactions with others. (Chen et al, 2022).

Much research on ASD has identified core impairments in various aspects of social life, including communication and social interaction, and speech and language. These disorders are thought to set the ASD population apart from the rest of the individual. Social communication skills include a variety of verbal and nonverbal abilities that are used in real life and dynamic social interactions, such as emotion recognition, emotion regulation, and eye gaze (Zhang et al, 2021). Limited social abilities require appropriate interventions to help individuals with ASD improve their social skills.

Currently, there is no clinical evidence that fully supports specific interventions for children with ASD. However, a large number of evidence-based interventions have been developed and used to help children with ASD at a young age. The most widely delivered evidence-based interventions include Applied Behavior Analysis (ABA), Picture Exchange Communication System (PECS), Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH), and Social-Communication, Emotional Regulation and Transactional Support (SCERTS). . In addition to the Evidence Based Practice above, recent studies have shown that virtual reality (VR) technology can be a promising medium for providing ASD interventions. (Li et al, 2023).

Virtual Reality (VR) has recently been studied and found to be a promising tool for addressing the psychoeducational needs of children with ASD in a variety of settings. There are several Evidence Based Practices that discuss VR in improving social skills in ASD cases, including "Using Virtual Reality to Teach Social Skills to Children with Autism Spectrum Disorder" (Parsons, Sarah et al. 2017), Virtual Reality Social Cognition Training for Children with High-Functioning Autism" (Bekele, Esubalew et al. (2013), and social adaptation training (eg Kandalaft, Didehbani, Krawczyk, Allen, & Chapman, 2013; Smith et al., 2014).

According to Liu et al (2023). It is important to note that many studies have identified the feasibility of using VR for instruction and intervention in the ASD group. VR can also help train ASD youth to engage in complex scenarios with higher communication demands. Regarding social skills training, research shows that children and youth with ASD can increase their social reciprocity and reduce social anxiety in VR settings. Contextual naturalistic interventions in a flexible VR environment incorporate precisely targeted interests and preferences of children into intervention activities. By mimicking real-world settings, VR allows children and young people with ASD to safely explore social situations that they might find difficult to handle in real life. Socially friendly virtual worlds can minimize social anxiety caused by inadequate recognition of expression and lack of social reciprocity. In particular, the safe, real-world scenarios created by VR can be reused and practiced indefinitely

VR technology has several potential advantages for interventions for children with ASD over other interventions. The VR environment provides safe and controlled yet highly interactive and realistic virtual scenarios, which can best facilitate the psychoeducational needs of people with ASD. More specifically, computer-generated graphics capture the attention and interest of people with ASD because many of them rely on visual thinking (Jacobson, 1978). Through VR technology, it can provide a safe and manipulated virtual experience where interventions can be carried out in a customized and step-by-step manner under the control of the therapist. In addition, the VR intervention reduced stress levels and was less likely to increase the anxiety or stress that is common in children and adolescents with ASD. The social deficits associated with ASD can lead to feelings of anxiety which impact on their social impairment. For example, social anxiety resulting from failed attempts at communication and interaction may contribute to an ASD individual's avoidance of social situations and lead to further isolation from their peers. VR technology can be combined with a gamified approach to promote stronger motivation, attention, focus, interest in tasks that individuals with ASD will achieve.

Based on the above background, to provide a better understanding of how VR can be selected and used to help individuals with autism. The researcher is finally interested in discussing the Literature Review entitled "Effectiveness of Virtual Reality (VR) in Improving Social Skills in Cases of Autism Spectrum Disorder: Literature Review"

2. Literature review

2.1. Definition

Autism Spectrum Disorder (ASD) is a neurobiological disorder characterized by persistent deficits in social communication and interaction, as well as restricted and repetitive patterns of behavior, interests, or activities (American Psychiatric Association [APA], 2013). ASD affects individual development from an early age, usually becoming apparent in the first

two years of life. The main symptoms of ASD include difficulty interacting socially, such as difficulty understanding facial expressions, establishing social relationships, and sharing interests with others. Individuals with ASD also tend to show limited interest in certain objects or topics and follow rigid routines.

2.2. Anatomy and Physiology

Several studies have identified anatomical and physiological differences associated with ASD. An understanding of the neuroanatomical and neurophysiological aspects involved in ASD can help explain the symptoms and characteristics of this disorder. Neuroanatomical research has uncovered several structural differences in the brains of individuals with ASD. For example, studies using brain imaging techniques such as magnetic resonance imaging (MRI) have shown differences in the size and volume of several brain areas in individuals with ASD. One area that is frequently researched is the prefrontal cortex, which is associated with higher levels of cognitive function and executive control. Several studies have shown that individuals with ASD have structural changes and affected connectivity in areas of the prefrontal cortex (Stoner et al., 2014; Nair et al., 2019). Research has found that individuals with ASD often display different patterns of brain activity, especially when it comes to social information processing. For example, EEG studies show differences in brain responses to facial expressions and social attention in individuals with ASD (Orekhova et al., 2008; McPartland et al., 2011). Genetic and pharmacological studies show differences in gene expression and neurotransmitter activity in individuals with ASD (Muller et al., 2016; Parker et al., 2017). Several genetic, environmental, and complex interaction factors are thought to play a role in the development of ASD (Buxbaum, Hof, & Buxbaum, 2018).

2.3. Epidemiology

Epidemiology is the study of the distribution and determinants of disease in populations. In the context of Autism Spectrum Disorder (ASD). Data from various countries show an increase in the prevalence of ASD in recent decades. According to the Centers for Disease Control and Prevention (CDC) in the United States, the prevalence of ASD in 2020 is around 1 in 54 children (CDC, 2020). Research on families with a history of ASD shows that having a family member with ASD can increase the risk of having a child with ASD (Sandin et al., 2014). Environmental risk factors have also been studied, including prenatal exposure to certain chemicals, infections, and perinatal factors such as prematurity (Schendel et al., 2009; Becerra et al., 2014). In addition, epidemiology also includes an understanding of the demographic characteristics of individuals with ASD. Research has also shown differences in the incidence of ASD between ethnic groups, with a higher incidence in individuals of Caucasian descent and individuals with highly educated family backgrounds (Baio et al., 2018; Bilder et al., 2009). Understanding the epidemiology of ASD is important in identifying vulnerable population groups and risk factors that may be involved in the development of this disorder. The epidemiological information obtained can

be used to direct more effective prevention, diagnosis, and intervention efforts for individuals with ASD.

2.4. Etiology

The etiology of Autism Spectrum Disorder (ASD) is complex and involves interactions between genetic and environmental factors. Although the exact cause of ASD is still unknown, research has identified several etiological factors associated with this disorder. For genetic factors strong evidence suggests that genetic factors play an important role in the development of ASD (Sandin et al., 2014). In addition, studies of distant relatives also indicate a genetic link in the development of ASD (Tick et al., 2016). Genetic research has identified various genetic variations associated with ASD, including certain gene mutations and structural abnormalities in chromosomes (Geschwind, 2011; De Rubeis et al., 2014). In the environmental factors several environmental factors have been associated with an increased risk of ASD. Epidemiological studies show that prenatal infections such as rubella and urinary tract infections can increase the risk of ASD in children (Atladóttir et al., 2010; Zerbo et al., 2013). Prenatal exposure to environmental pollutants, such as heavy metals and air pollutants, has also been associated with an increased risk of ASD (Volk et al., 2013; Raz et al., 2018). In addition, perinatal factors such as pregnancy complications, prematurity, and low birth weight have also been associated with a higher risk of ASD (Bilder et al., 2009; Kuban et al., 2019). Several studies suggest that individuals with certain genetic susceptibility may be more susceptible to adverse environmental effects in developing ASD (Gaugler et al., 2014; Shelton & Brown, 2016). For example, prenatal exposure to certain environmental pollutants such as pesticides can have a greater effect on children with a high genetic susceptibility to ASD (Von Ehrenstein et al., 2019). This interaction emphasizes the importance of viewing ASD as the result of a complexity of genetic and environmental factors. Research continues to strive to better understand the etiology of ASD. A multidisciplinary approach involving genetics, neurobiology, and environmental science is needed to identify more specific etiological factors and understand the interactions between these factors, including: Etiology of Prenatal, Natal, and Postnatal Periods in Autism Spectrum Disorder (ASD).

2.5. Pathophysiology

One of the important aspects in the pathophysiology of ASD is the dysfunction of synapses and communication between neurons. Research has found changes in synaptic structure, function, and connectivity in individuals with ASD (Hutsler & Zhang, 2010). In addition, disturbances in the signaling pathways and expression of genes involved in the formation and function of synapses have also been observed (Geschwind, 2011; Betancur et al., 2009). MRI studies have identified changes in cortical volume and thickness as well as disturbances in functional connectivity between brain areas (Ecker et al., 2015; Supekar & Menon, 2015). Disturbances in autonomic responses, such as regulation of heart rate and stress response, have been observed in individuals with ASD (Ming et al., 2005; Porges et

al., 2013). This suggests that the involvement of the autonomic nervous system in emotion regulation, social interaction, and sensory perception is impaired in ASD. However, it is important to note that the pathophysiology of ASD is complex and multifactorial. Interactions between genetic, environmental, and epigenetic influences play a role in the development of ASD. These pathophysiological changes can affect normal developmental pathways, leading to disturbances in social interaction, communication, and behavior patterns that are characteristic of ASD.

Pathophysiology of Autism Spectrum Disorder (ASD) involves neurobiological changes that occur in the prenatal, natal, and postnatal periods. These factors can affect the development of the brain and nervous system, which in turn influences the symptoms and manifestations of ASD. 1) Prenatal Period: In the prenatal period, several factors have been associated with an increased risk of ASD. For example, studies have shown that prenatal exposure to infection or inflammation can affect fetal brain development and increase the risk of ASD (Atladóttir et al., 2010; Zerbo et al., 2013). Prenatal exposure to toxic chemicals such as mercury, lead, and pesticides has also been associated with an increased risk of ASD (Lyall et al., 2017; Shelton et al., 2014). In addition, genetic factors involved in the regulation of brain development and synaptic function can also play an important role in the prenatal period in influencing ASD risk (Stamouli & Garas, 2019). 2) Natal period: several studies have linked labor complications with an increased risk of ASD. For example, premature birth, low birth weight, and lack of oxygen at birth (asphyxia) have been associated with an increased risk of ASD (Bilder et al., 2009; Kuban et al., 2019). These factors can influence brain development and synapse function in critical periods of development. 3) Postnatal Period: Pathophysiological changes in the postnatal period may also contribute to the development of ASD. For example, changes in the immune system and inflammation early in life may play a role in the development of ASD (Patterson, 2011). Disorders of the digestive tract, including intestinal dysbiosis (disorder of the microbial balance in the gut) and food intolerance, have also been associated with ASD symptoms (Elsabbagh et al., 2012; de Theije et al., 2014).

2.6. Clinical Manifestations

Clinical manifestations of Autism Spectrum Disorder (ASD) vary widely, but generally include deficits in social interaction, communication, and restricted or repetitive patterns of behavior. ASD symptoms can appear from an early age, although the severity and type of symptoms can vary between individuals. Firstly, social interaction, such as individuals with ASD tend to have difficulty understanding and responding to facial expressions, body language, and difficulties in establishing and maintaining social relationships (American Psychiatric Association, 2013). Secondly, communication, individuals with ASD may have difficulty understanding and using verbal and nonverbal language well. They can experience speech delays, problems understanding the meaning of words, or difficulty practicing eye contact when communicating (American Psychiatric Association, 2013). Lastly, restricted and repetitive patterns of behavior, individuals with ASD often show

strong interest and repeated involvement in certain objects or topics (American Psychiatric Association, 2013).

2.7. Classification

The classification of Autism Spectrum Disorder (ASD) is based on the classification system used in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) published by the American Psychiatric Association.

According to the DSM-5, there are three main diagnoses that fall within the ASD spectrum 1) Autism Spectrum Disorder (ASD): This is a primary diagnosis that covers a wide range of severity of ASD symptoms, ranging from mild to severe. 2) Asperger's Syndrome: In the DSM-5, Asperger's Syndrome is no longer used as a separate diagnosis, but individuals previously diagnosed with Asperger's Syndrome can now be grouped under the ASD category. 3) Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS): This diagnosis is also not used in the DSM-5. The DSM-5 classification serves as an important guide for mental health professionals in making an accurate and consistent diagnosis of ASD.

2.8. Diagnosis

Diagnosis of Autism Spectrum Disorder (ASD) is based on a comprehensive evaluation involving behavioral observations, interviews with parents or caregivers, and the use of standardized diagnostic tools. The diagnosis process is carried out by a trained health professional, such as a psychiatrist, psychologist or child development specialist. Some of the main criteria that must be met for an ASD diagnosis include: 1) Deficits in social interaction: Individuals with ASD have difficulty interacting adequately in social situations. 2) Deficit in communication: Individuals with ASD may experience speech delays, difficulty understanding and using language properly, and may display stereotyped or repetitive use of language. 3) Restricted and repetitive patterns of behavior: ASD is often characterized by intense interest in certain objects or topics, repetition of certain body movements or activities, and difficulty coping with change or transition.

2.9. Prognosis

The prognosis for individuals with ASD will differ according to several factors, including the age found, the severity of symptoms, providing appropriate care, and a supportive environment for the therapeutic process to occur for children (McDougle, 2016). Individuals with mild ASD, have an IQ equivalent to average or more, and get care and an environment to support social skills are usually able to attend education and even get a job (Styles et al., 2020). The success of the treatment given can improve communication skills as well as social affective symptoms and repetitive behavior can also change (Hyman et al., 2020). Based on the research conducted, it was found that interventions given to children

with early signs of ASD aged 9 months – 3 years showed a reduction in the severity of ASD symptoms and even reduced the likelihood of an ASD diagnosis at 3 years of age (Whitehouse et al., 2021).

2.10. Intervention

2.10.1 Virtual Reality (VR)

Virtual Reality (VR) Is a term in which an artificial environment is displayed through visual and auditory stimulation by producing realistic images or other sensations that simulate a sense of presence. VR is considered suitable for simulating naturalistic situations and, because it is not limited to geographic locations. (Dechsling, Shic, et al., 2021). The highest level of immersive experience is delivered in head-mounted display (HMD) consumer products that are now affordable or in Cave Automatic Virtual Environments (CAVE; Miller & Bugnariu, 2016). HMD is a wearable mobile headset that is equipped with a projector while isolating visual stimuli from the real environment to provide a full sense of the virtual environment around the user and allow them to interact directly and get sensory feedback. On the other hand, CAVE presents a pseudo-three-dimensional environment without the wearable using multiple displays that are two-dimensionally projected around the user or using a motion sensor camera. (Dechsling, Hansen., 2023).

2.10.2 Virtual Reality Intervention to improve social skills in ASD

Virtual Reality (VR) Intervention-based Occupational Therapy has been a promising approach to improving social skills in individuals with Autism Spectrum Disorder (ASD). For example, a study by Parsons et al. (2017) evaluated the effects of Occupational Therapy-based VR interventions in children with ASD. The results showed a significant increase in social communication skills and interactions with peers after the intervention. ASD is a neurobiological developmental disorder characterized by deficits in social interaction, verbal and nonverbal communication, and restricted and repetitive behavior (American Psychiatric Association, 2013). Several studies have demonstrated the effectiveness of Occupational Therapy-based VR Intervention in improving social skills in individuals with ASD. For example, a study conducted by Parsons et al. (2017) engaged children with ASD in a VR intervention over a period of time. The results showed a significant increase in social communication skills and interactions with peers after the intervention. Another study by Smith et al. (2019) also demonstrated increased social engagement in individuals with ASD after using Occupational Therapy-based VR Intervention.

2.11 Outcome Measure

Outcomes Measure or outcome measurement is an important component in evaluating the effectiveness of Virtual Reality (VR) Intervention-based Occupational Therapy to improve social skills in individuals with Autism Spectrum Disorder (ASD). In this context, outcome

measures are used to evaluate the impact of VR interventions on changes in social skills, social interactions, and social functioning of individuals with ASD. Social skills are explained as the assumption of a healthy social life (Osit, 2008), which is very important in the pursuit of personal sovereignty, the ability to adapt to social situations, express oneself and understand others (Colombero, 2004); to communicate avoiding conflict, to maintain good interpersonal skills (Brodeski, Hembrought, 2007); social skills are an important condition for a harmonious existence in a social group, the possibility for a person to act effectively in a social environment, and the assumption of successful socialization. C. Canney and A. Byrne (2006) classify social skills based on their areas of expression such as foundation skills or basic skills, interaction skills or interaction skills, emotional skills, and cognitive skills. Some of the outcomes measures that are often used in related research include Social Responsiveness Scale (SRS), measurement tool specifically designed to identify and measure autism symptoms, Autism Diagnostic Observation Schedule (ADOS): ADOS is the standard instrument used in the diagnosis of ASD. This is an interactive test that observes the individual's social and communication behavior during interactions with the examiner (Lord et al., 2012). Social Skills Improvement System (SSIS): SSIS is a measurement tool designed to measure social skills and adaptive behavior in children and adolescents. This tool covers aspects such as social skills, communication skills, and social courage (Gresham & Elliott, 2008). Vineland Adaptive Behavior Scales (VABS): VABS is a measurement tool used to evaluate adaptive skills in individuals with developmental disorders, including ASD. This scale covers domains such as communication, everyday life, social skills, and personal independence (Sparrow et al., 2005).

3. Methodology

A comprehensive literature search was conducted to identify relevant studies published between January 2018 and June 2023. The search was limited to English-language publications. Studies that employed VR as an intervention to enhance social skills in individuals diagnosed with ASD were included in the review. The method used is literature review. This research was conducted on 13-15 June 2023.

3.1 Inclusion and Exclusion Criteria

Inclusion Criteria is an explanation of the factors that will be selected to enter articles and be reviewed. Exclusion criteria is explanations of the search factors are not included in the articles to be reviewed. The author's inclusion and exclusion criteria are presented in table 3.1

Table 3.1 Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Population/ problem	● Boys and girls aged 4–12 years ● Patients with a diagnosis Autism Spectrum Disorder	● Patients with a diagnosis of Down Syndrome, Intellectual Disability, ADHD, Visual,

		Auditory and Motor Impairment
Intervention	● Using Virtual Reality intervention	● Using Augmented Reality intervention
Comparation	There is no comparison intervention	
Outcome	Social Skill	● Articles that do not evaluate Motor skill
Study Design	● Randomized Controlled Trial (RCT) ● Experimental study ● Pilot study ● Cohort study	● Systematic review ● Literature review
Publication Year	Articles or journals published in 2018 (last 5 years)	Articles or journals published before 2018
Language	English and Indonesian	Apart from English and Indonesian

3.2 Literature Search Strategy

The strategy used to find articles using the PICO framework: 1) Population/problem is Autism Spectrum Disorder, 2) The intervention used is Virtual Reality (VR), 3) Comparation is not done, 4) The desired outcome is Social Skills. Search for articles or journals using keywords and Boolean operators (AND, OR NOR or AND NOT) which are used to broaden or specify searches to make it easier to determine the publications used. A search was conducted via PubMed, Science Direct, Google Scholar, EBSCohost and Scopus on June 14, 2023. The search strategy can be seen in **table 3.2.** and search engine can be seen in **table 3.2.**

Table 3.2 Literature Search Strategy

Population		***Intervention***		**Outcome**
ASD		*Virtual Reality*		Social Skill
OR		**OR**		**OR**
Autism Spectrum Disorder	**AND**	Virtual Stimulation	**AND**	Social Competence
OR		**OR**		
Autistic Disorder		Immersive Multimedia		Interpersonal skill
		OR		
		Virtual Experience		Social Intelligence

Table 3.3 Search Engine

Date	Database	Year	Keyword	Numbers of article founs
June 13-15 2023	PubMed	2018-2023	ASD OR *Autism Spectrum Disorder* OR *Autistic Disorder* AND *Virtual Reality* AND *Immersive Multimedia* OR *Virtual Stimulation* OR *Virtual Experience* AND *Social Skill* OR *Interpersonal Skill* OR *Social Competence* OR *Social Intelligence*	104
	Science Direct			83
	Google Scholar			64
	EBSCohost			63
	Scopus			1

Articles that have been found from several databases are then screened for titles and abstracts, as well as inclusion-exclusion criteria. Articles that pass the inclusion criteria are then evaluated with the JBI Critical Appraisal Tools. The number of people doing the appraisal is two people, and if there is an argument or debate between the two reviewers, the supervising lecturer will be the third reviewer.

3.3 Data Extraction and Synthesis Methods

The author uses a simplified approach by Aveyard. The Simplified Approach has been widely used by students to complete a literature review in the field of health and social care which has been refined and modified according to feedback and experiences from people who have used it. The process of summarizing the article aims to get the contents and provide information on the differences in the methods that exist in each article. Then it will give an overall picture and make it easier for the writer to understand the correlation between the articles he gets. The next is identihis stage is the process of identifying themes that will be used in the articles obtained. This process can be started from drawing conclusions and findings on each article obtained, then paraphrasing it in the author's language. After that, develop the theme starting from combining the same themes and findings from the previous process. However, it is still advisable to keep the original publication in order to check the suitability of the theme to be developed. Close control of the theme because writers are required to pay close attention to the themes developed and consider how each theme is interrelated. Therefore, at this stage it is necessary to review the original publication in order to find further information for the analysis process. Lastly is overcoming inappropriate themes, if one theme differs from another or does not support one another, the writer looks back at the critical appraisal that has been made to assess where the theme came from, the strengths and limitations of the article.

4. Results and Discussion

4.1 Search Results

Based on search results through PubMed, Science Direct, Google Scholar, EBSCohost and Scopus publications. Using the keywords "ASD OR Autism Spectrum Disorder OR Autistic Disorder AND Virtual Reality AND Immersive Multimedia OR Virtual Stimulation OR Virtual Experience AND Social Skill OR Interpersonal Skill OR Social Competence OR Social Intelligence". Researchers found 315 articles that match these keywords. The research journals were then screened by reading the abstract titles, the researchers found 5 journals. Then the research article is read thoroughly. Based on these results, 5 articles included the inclusion criteria.

Table 4.1 Article synthesis

Database	**The number of references obtained**		
	On the database using PICO	**After reviewing the title and abstract**	**After reading the article in its entirety**
PubMed	104	1	1
Science Direct	83	1	1
Google Scholar	64	3	3
EBSCohost	63	0	0
Scopus	1	0	0
Number of articles that have been critically appraised			**5**
Number of articles reviewed			**5**

Table 4.2 Critical Appraisal Results

No	**Article**	**Assessor score (X)**	**Assessor score (Y)**	**Agreed score**	**Inclusion or Exclusion**
1.	*Virtual Reality-Based Social Skills Training for Children With Autism Spectrum Disorder*	13/13	13/13	13/13	Inclusion
2.	*Comparing the Effect of Risperidone, Virtual Reality and Risperidone on Social Skills, and Behavioral Problems in Children with Autism: A Follow-up Randomized Clinical Trial*	13/13	13/13	13/13	Inclusion

3.	*Using Virtual Reality to Train Emotional and Social Skills in Children with Autism Spectrum Disorder*	13/13	13/13	13/13	Inclusion
4.	*Effectiveness of avatar-delivered instruction on social initiations by children with Autism Spectrum Disorder*	9/9	9/9	9/9	Inclusion
5.	*Children on the Autism Spectrum and the Use of Virtual Reality for Supporting Social Skills*	13/13	11/13	12/13	Inclusion

This literature review contains five articles that meet the inclusion requirements according to the inclusion and exclusion criteria described in chapter III. The following is the flow of PRISMA from the research results in **Figure 4.1**.

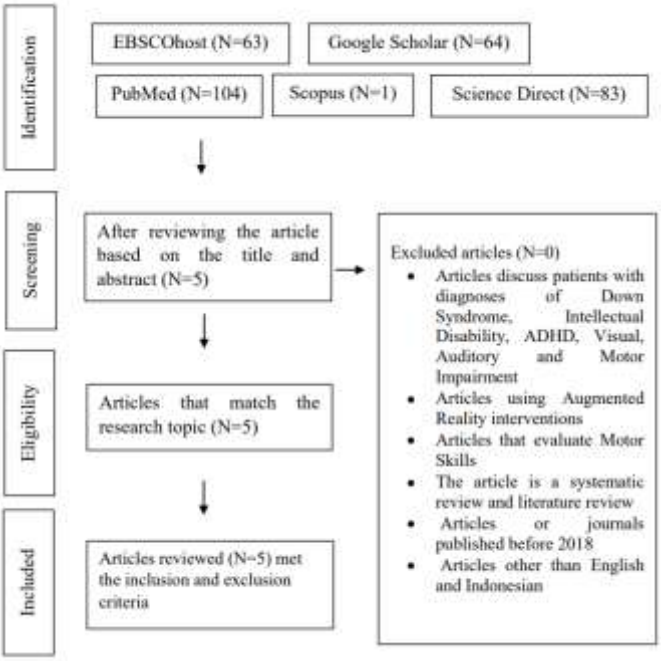

Figure 4.1 Prisma chart

4.2 Results of Literature Review

Based on the five case studies conducted at different research sites. Of the five case studies, most were conducted in the United States. The place where the study was conducted can be seen in **table 4.3.**

Table 4.3 Design studies

No	Study	Year	Setting	Design study	Level of Evidence
1	Ke, et al.[26]	2020	USA	RCT	1
2	Kouhbanani, et al.[27]	2021	Iran	RCT	1
3	Yuan, et al.[28]	2018	UK	RCT	1
4	Charlton, et al.[21]	2020	USA	QED	2
5	Frolli, et al.[24]	2022	Italy	RCT	1

Table 4.4 Demography

Study	Sample	Age	Gender
Ke, et al.	T = 7 C (*Control*) = - I (*Inter*) = 7	10-12 years old	Boys (6) and Girls (1)
Kouhbanani, et al	T = 43 R *(Risp)* = 15 C = 13 RVR (*Risp + VR)* = 15	6 – 12 years old	Boys and Girls
Yuan, et al.	T = 72 C (*Control)* = 36 I (*Inter)* = 36	Average age 8 years	Boys (64) and Girls (8)
Charlton, et al.	T = 9 C (*Control*) = 4 I (*Inter)* = 5	8-10 years old	Boys and Girls
Frolli, et al.	T = 60 C (*Control*) = 30 I (*Inter*) = 30	9-10 years old	Boys (51) and Girls (9)

4.3 Intervension

Table 4.5 Intervension

Study	Group Treatment A	Group Treatment B	Group Kontrol	Follow-up
Ke, et al.	The experimental group was given an intervention with VR via an internet	-	-	Follow-up on 4 children, 1 month after

	connection on a computer. The VR-based learning environment supports role play in socializing, playing, going to school, and designing in children with autism. Participants were given 1 hour of training on the use of VR before the intervention. Intervention duration is 45 – 75 minutes per session, with 1-2 sessions per week. Social communication and social skills questionnaires were conducted before and after the training program.			intervention with 3-5 observation points.
Kouhbanani, et al	The first experimental group is a combination of virtual reality with the drug risperidone. The intervention is carried out at home by the parents with a special smartphone. Parents use bluetooth to transfer photo & video interventions to child's VR glasses. The intervention was carried out every day for 45 minutes per session, with a total of 90 sessions. A pre-test was performed before the first intervention and a post-test after the last intervention. The dose of risperidone in children weighing 14-20 kg is 0.25 mg/day (increasing progressively to 1.75 mg/day) and in children weighing 20-40 kg, namely 0.5 mg/day (increasing gradually, a maximum of	The second experimental group was only given risperidone drug therapy. The dose administered by the psychiatrist was determined in the same way as the other groups.	No intervension	Followed up after 3 months of intervention.

	2.25 mg/day). day), and at >45 kg that is 0.5 mg/day (increase gradually, max 3.5 mg/day).			
Yuan, et al.	The training group was given a VR training program with Cave Automatic Virtual Environment (CAVE) individually for 1 hour. There are 6 learning scenarios designed, including a relaxation scenario, four training scenarios and one consolidation scenario. The PEP-3 Psychoeducation Profile was used to assess the effect of the training on the results of affective expression and social reciprocity before and after the VR training.	-	No intervension	-
Charlton, et al.	There were 5 children with autism who were given intervention using the instructions given by the avatar. The chosen avatar is Marla, who is a colorful fish with an expressive face. The avatar is controlled by a female pilot. Participants completed at least 4 sessions on different days for an average of 6 trials per session. Marla will provide a step-by-step social skills lesson with a script and then help participants start conversations with interventionists.	-	There are 4 normal peers to evaluate the acquisition of participants with autism. They were given no training and were only told to talk to the participants. The instructions given were that they had to wait for the autistic participants to talk first.	-

Frolli, et al.	The first experimental group (Gr1) was given a VR (Virtual Reality) intervention. The VR emotional intervention involves the 3D projection of two sequences of scenes shot with the same actor from 76 photographs. The first sequence is 38 scenes of which 14 refer to 7 primary emotions and 24 refer to 12 secondary emotions. The second sequence contains projections of 38 scenes, 14 of which refer to primary situations and emotions and 24 refer to secondary situations and emotions. The duration of the experiment was 3x a week for 3 months.	The second experimental group (Gr2) was given intervention individually with the therapist. Emotional literacy intervention using 76 sequential photos. A total of 38 first sequences were given 14 photos with 7 primary emotions (2 for each primary emotion, 1 for children and 1 for adults) and 24 with recognition of 12 secondary emotions. The second sequence of 38 photos was then given to a child with High Functioning Autism. The scenario of the situation before the photo is explained, and then a picture depicting the emotion appropriate to the situation is presented. Situations were	-	-

		correlated for 14 primary emotion photographs and 24 secondary emotion photographs.	

Table 4.6 Outcome measure

Study	Year	Outcome measure Balance	Others outcome measure
Ke, et al.	2020	*Social Communication Questionnaire* (SCQ), *Social Skills Questionnaire* (SSQ)	-
Kouhbanani, et al.	2021	*Childhood Autism Rating Scale* (CARS-II), *Vineland Adaptive Behavior Scale*	-
Yuan, et al	2018	*Physchoeducational Profile, Third Edtion* (PEP-3)	-
Charlton, et al.	2020	*Social Skill Mastery, Social Skills Improvement System rating Scales* (SSIS) *-parent form, Autism Diagnostic Observation Schedule* (ADOS), AA	-
Frolli, et al.	2022	*Autism Diagnostic Observation Schedule* (ADOS)	-

Five articles included in this study, there was quite high heterogeneity starting from gender, differences in dosage, Outcome Measure and Homogeneity of the inclusion articles in the form of providing Virtual Therapy interventions, Conditions of Autism Spectrum Disorder patients, Age, namely the age range of 4-12 years , Study Design Thus, this literature review uses a narrative technique to present the results of the literature review.

4.4 Effectiveness of Using Virtual Reality (VR) in Improving Social Skills in Cases of Autism Spectrum Disorder

Based on the five articles reviewed, it was found that the provision of Virtual Reality has proven effective in improving social skills in cases of Autism Spectrum Disorder. In the research by Ke Feng-Feng et al. 26, 7 participants were divided into 2 groups and then an intervention was carried out using Virtual Reality for 1 month. Then social skills were measured using the Social Communication Questionnaire (SCQ), Social Skills Questionnaire (SSQ), re-evaluated Follow-up was carried out on 4 children, 1 month after the intervention with 3-5 observation points. Based on the graphical data series and nonoverlap metrics (Tau-U) calculated with the baseline data and the intervention showed an increase in social skills performance by the participants. Initiation of social interaction shows an average Tau-U value of participants 0.64; $p < 0.001$ and Tau-U 0.52 ; $p = 0.1$ of the 2 subgroups, indicating a significant increase. Individual analysis for initiation also showed improvement, except for participant 5.

In interpersonal negotiations, the average Tau-U value is 0.75; $p < 0.001$ and Tau-U 0.64 ; $p < 0.002$ in 2 subgroups, meaning that the intervention phase showed a significant increase. However, for participants 1 and 5-7, it took 3-5 sessions until the negotiation improved and was successful, from being non-communicative to being more opinionated and expressing verbal & non-verbal.

In the expression of positive self-identity, it shows a Tau-U value of 0.54; $p < 0.001$ and Tau-U 0.24 ; $p > 0.05$ from each sub group. Interphase increase was moderate and significant in the first subgroup but small and insignificant in the other subgroups. In cognitive flexibility, the average Tau-U value is 0.52; $p < 0.001$ and Tau-U 0.66 ; $p < 0.001$, in each sub-group, meaning that the intervention phase data showed a significant increase. In line with Kouhbanani's research, et al. 28, the 43 participants were divided into 3 groups and then intervened for 3 months. using Virtual Reality then social skills were measured using the Childhood Autism Rating Scale (CARS-II), Vineland Adaptive Behavior Scale, followed-up after 3 months of intervention. There were significant mean differences in social skills scores between pre-test and post-test (MD = 37.73; $p<0.001$) and between pre-test & 3 months follow-up in the risperidone + VR group (MD = 29.866; $p <0.001$). Whereas there was no significant difference in the pre-test & 3 months follow-up in the risperidone group (MD = 4.93; $p = 0.843$).

The results of the comparison between groups showed that in the post-test, risperidone + VR showed a significant increase in social skills scores compared to the control group (MD = 36.59; $p<0.001$). Also, the risperidone group showed a significant increase in social skills scores compared to the control group (MD = 2.03; $p<0.001$), while there was no significant difference between the risperidone and risperidone + VR groups in social skills scores (MD 36.56; $p = 0.643$) . In follow-up, only the risperidone + VR group showed a significant difference compared to the control group (MD = 19.63; $p<0.001$), whereas there was no significant difference between the risperidone and control groups (MD = -1.37;$p = 0.751$). MD = average difference between pre test and post test. This is the same as the research conducted by Yuan et al. 26's research on 72 participants who were divided into 2 groups and then intervened using Virtual Reality. Then social skills are measured using the Physchoeducational Profile, Third Edition (PEP-3). The results showed that there was an increase in the value of social interaction and adaptation after training ($p<0.005$) from M = 20.2 ; SD = 3.43 to M = 21.8 ; SD = 2.99. Measures with ANOVA also showed significant group and time interaction results on social reciprocity ($p = 0.007$).

Research conducted by Charlton, et al 26 on 9 participants who were divided into 2 groups and then conducted an intervention using Virtual Reality. Then social skills were measured using Social Skill Mastery, Social Skills Improvement System rating Scales (SSIS) -parent form, Autism Diagnostic Observation Schedule (ADOS), AA. The results showed that all participants experienced an increase in social skills after being given the intervention. Effect sizes related to baseline for intervention contrast were Baseline Corrected Tau = 0.62 to

0.86 ; p<.01. The effect size for baseline to generalization contrast is Baseline Corrected Tau = 0.58 to 0.92 ; p<.01.

Frolli, et al. also carried out 60 participants who were divided into 2 groups and then intervened using virtual reality then social abilities were measured using the Autism Diagnostic Observation Schedule (ADOS).

4.5 Knowing the appropriate method and dosage of using Virtual Reality (VR) in improving social skills in children with Autism Spectrum Disorder

Five articles reviewed stated that VR was effective in improving social skills in children with ASD. Research conducted by Ke, et al. the intervention was given for 1 month with an intervention duration of 45-75 minutes per session, with 1-2 sessions per week. The graphical data series and nonoverlap metrics (Tau-U) calculated with the baseline and intervention data show an increase in social skills performance by the participants. In interpersonal negotiations showed a significant increase. However, for participants 1 and 5-7, it took 3-5 sessions until the negotiation improved and was successful, from being non-communicative to being more opinionated and expressing verbal & non-verbal. This shows that individual abilities affect the method and dose given. On cognitive flexibility also showed a significant increase.

This is in line with Kouhbanani, et al who provided intervention for 3 months with interventions carried out every day for 45 minutes per session, with a total of 90 sessions. In this intervention, it was divided between the Risperidone, VR + Risperidone + Control groups. In the VR + Risperidone group there was a significant mean difference in social skills scores between the pre-test and post-test while there was no significant difference in the pre-test & 3 months follow up in the Risperidone group. Then, in the follow-up, only the risperidone + VR group showed a significant difference compared to the control group while there was no significant difference between the risperidone and the control group. In line with research conducted by Frolli, et al. with the duration of the experiment given ie 3x a week for 3 months. The results show the significant time factor in PE indicating a change over time.

SE, ESPE, and ESSE showed significant time factors ($p < 0.05$), so both interventions (Gr1 & Gr2) were effective. Between-group factors and group interaction time were significant ($p < 0.05$), results revealed significant differences between the two interventions, indicating greater effectiveness of the VR intervention when compared to the other treatments. Intervention dose in a study conducted by Yuan, et al. for 1 hour made an increase in the value of social interaction and adaptation after training ($p<0.005$) from M = 20.2 ; SD = 3.43 to M = 21.8 ; SD = 2.99. Measures with ANOVA also showed significant group and time interaction results on social reciprocity ($p = 0.007$).

Unlike the research conducted by Charlton, et al. The doses were administered in 4 sessions on different days with an average of 6 trials per session. All participants showed an increase in social skills even with several different intervention trials for each individual. Thus, that the correct dosage for VR use is influenced by several things. Both individual ability, high and low doses and repeated practice.

4.6 Research gaps and challenges in using VR as a therapeutic tool to improve social skills in individuals with ASD.

Although the use of Virtual Reality (VR) as a therapeutic tool to improve social skills in individuals with Autism Spectrum Disorder (ASD) holds promise, there are still several research gaps and challenges that need to be addressed. Here are some of them:

1. Gaps in research involving a representative sample: While there has been some research that has been conducted on the effectiveness of VR in improving social skills in individuals with ASD, there are still gaps in research involving large and representative samples. Many of the current studies involve a limited number of participants, making it difficult to generalize their findings. Further research with a larger and more representative number of participants is needed to provide a more comprehensive understanding of the effectiveness of VR in improving the social skills of individuals with ASD.
2. Diversity of individuals with ASD: ASD is a wide spectrum, with variations in individual characteristics and needs. The challenge is to create VR programs that can be adapted to different individual needs and preferences. Each individual with ASD may have unique challenges and strengths, so there needs to be a flexible and adaptable approach to meet each individual's needs.
3. Consistent outcome measures: In research into using VR as a therapeutic tool, there needs to be consistent and standardized outcome measures to evaluate its effectiveness. Currently, there are still variations in the measurement tools used in research, which makes it difficult to compare study results directly. It is necessary to develop valid and reliable measurement tools that can accurately measure changes in social skills.
4. Accessibility and cost: Although VR technology has advanced rapidly, accessibility and cost remain constraints. VR equipment required for therapy may be expensive and not widely available. This can limit the access of individuals with ASD to VR therapy. In addition, therapists trained in using VR as a therapeutic tool may also be limited, making widespread implementation difficult.
5. Use of VR in everyday life: While VR can assist individuals with ASD in practicing social skills, the challenge is transferring the skills learned in a VR environment to everyday life. It is important to ensure that skills mastered in a virtual environment can be applied and maintained in real situations outside of a VR environment.

Although there are several research gaps and challenges in using VR as a therapeutic tool to improve social skills in individuals with ASD, research and development continues to

address these issues. There are limitations in this literature review, in the form of limited processing time and also researchers who do not understand more deeply about the Literature Review so that researchers are still not optimal in working on this literature.

5. Conclusion

Based on literature reviews conducted on the aforementioned journals, occupational therapy-based Virtual Reality Intervention shows significant potential in improving social skills in individuals with Autism Spectrum Disorder (ASD). Various studies have shown that the use of Virtual Reality (VR) technology in the context of occupational therapy interventions can provide positive benefits in developing social skills in children with ASD. Studies conducted in populations of children with ASD show that VR can be used as an effective tool in facilitating social learning and enhancing social interaction. This VR-based intervention is able to create a safe and controlled simulated environment, where individuals with ASD can practice in a variety of social situations more confidently and more comfortably. The use of VR technology also allows the therapist to present tasks that can be personalized according to individual needs and interests, increasing motivation and involvement in the therapy process. However, although Virtual Reality Intervention shows promising potential, there are some limitations in the literature that need to be considered. One limitation is the lack of consistency in the outcome measures and assessment methods used in these studies. Several studies used different measurement tools, making it difficult to compare results directly. In addition, several journals also have relatively small sample sizes, so it is necessary to pay attention to the generalization of the results of this study.

6. Ethical Approval

As this study is a literature review that synthesizes existing research, there was no need for ethical approval since it does not involve direct data collection from human subjects. The review strictly adhered to ethical guidelines by using publicly available published studies and maintaining confidentiality and anonymity of the participants in the original research studies.

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