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The contribution of artificial intelligence in people with autism: a systematic literature review

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ABSTRACT

Autism is a disorder that poses significant challenges in various areas such as health, education, social interaction, and how the world perceives them. The implementation of artificial intelligence in daily life and different fields offers an innovative approach to addressing these challenges, facilitating early detection, support in learning, and social interaction for individuals with this condition. The systematic literature review focuses on studying 50 out of 144 articles obtained from various databases such as EBSCO Host, IEEE Xplore, ScienceDirect, Scopus, ProQuest, and Web of Science. These articles were systematically organized using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) methodology, providing information about machine learning as the most utilized discipline, the types of infrastructure it relies on, and the countries that are at the forefront of this topic. This review will serve as a reference for stakeholders regarding the advancements and contributions of artificial intelligence for individuals with autism.

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1. INTRODUCTION

Autism is a disorder that constitutes several brain-related conditions, and it often cannot be detected until well after infancy. According to the United Nations [1], approximately 1 in 100 children born with autism are often stigmatized and even discriminated against, depriving them of opportunities. In September 2015, the United Nations instituted the sustainable development goals (SDGs) [2]. SDG10 "reducing inequalities" aims to reduce inequality within and between countries [3]. The SDGs each have many more specific targets, such as SDG10.2 aims to empower and promote the social, economic, and political inclusion of all people, regardless of age, gender, disability, race, ethnicity, origin, religion, or economic or other status [4].

The United Nations mentions that about 70 million people worldwide are on the autism spectrum [5]. In addition, Statista indicates that, in 2022, out of 20 selected countries; for every 10,000 children 80 of them suffer from autism in the USA; more than 85 in countries such as Colombia, Canada, and Japan; Saudi Arabia has more than 100 children with this problem; and, at the top of the list Qatar with more than 150 for every 10,000 children [6]. According to data provided by the Data Resource Center for Child and Adolescent Health from the National Survey of Children's Health in the years 2021-2022, of all USA, Hawaii has 1.7% of children with autism between the ages of 3 and 17; likewise, Florida is the state with the highest percentage with 5.2% [7]. In many countries, they do not have easy access to a good education, with few opportunities for good employment, health restrictions, and social discrimination [5]. In addition, 79% of people with disabilities, including autism, are not working in the workplace in the USA, and 40% are unable

to find employment after rehabilitation [8]. However, the Centers for Disease Control and Prevention has found data indicating improved awareness and access to low-income communities for identifying children with autism and getting them the services they need as early as possible [9].

A Swedish study by Karolinska Institute has shown that a machine learning model can predict autism in children under two years of age by almost 80% by analyzing a combination of 28 different parameters [10]. This high accuracy demonstrates the potential of artificial intelligence in early autism detection, which is crucial for timely intervention. Furthermore, such advancements could significantly reduce the diagnostic delays that many children with autism currently face.

This type of technology can be a springboard for the constant load of information, both in image processing, decision-making, and data-driven analysis [11]. In addition, it is not only limited to early detection in people with autism; it also helps to cope with their discomfort with loud noises and even in social interaction, through different types of artificial intelligence (applications and robots) [12]. In 1935, the abstract computing machine was invented, which modified its algorithm concerning the instructions in its memory, thus giving birth to artificial intelligence [13]. Currently, artificial intelligence continues to improve, and this has been of great help to many countries in the world, with the USA leading the use of this tool, China in second place, and Brazil is the only Latin American country that is among the 17 countries that use artificial intelligence the most [14]. This technology is already part of our lives, and as it allows us to develop, it can also raise issues such as the ethics of its use, intervention in education, and other aspects [15]. However, it has been used in a positive way to improve the quality of life of people with autism, as in the case of Congresswoman Vásquez García Dionicia, who promotes the initiative of artificial intelligence, robotics, and virtual reality as a means of inclusion, adaptability, and development in various areas of society for people with autism [16]. The purpose of this research was to examine a variety of articles to identify the contribution of artificial intelligence to people with autism. The objective is to discover different alternatives to improve the quality of life of these people.

2. METHOD

The study model used is the systematic literature review [17], with preferred reporting items for systematic reviews and meta-analyses (PRISMA) methodology [18]. The PRISMA framework ensures transparency and rigor in the review process, which is essential for producing reliable results. By adhering to this methodology, the study minimizes bias and enhances the reproducibility of its findings. This type of tool helps systematic reviews to be done in a clear and detailed way, improving the quality, allowing us to understand the objectives, processes, and findings of the reviews, as well as helping to search for more related articles to present the systematic literature review.

2.1. Research questions

To address the systematic literature review objective and highlight the attributes for answering it, the following four research questions (RQs) were formulated:

- RQ1: which artificial intelligence tools have been most used in recent years to improve the quality of life of people with autism?
- RQ2: what type of infrastructure has been most commonly used in the studies of people with autism using artificial intelligence?
- RQ3: how can artificial intelligence improve the social, academic, and health lives of people with autism?
- RQ4: which countries are most actively implementing artificial intelligence for social and emotional development in people with autism?

2.2. Search strategies

The articles were searched in highly reliable virtual databases such as Scopus, IEEE Xplore, ProQuest, Science Direct, Web of Science, and EBSCO. Through these sources, search terms and the literary resources to be used can be evidenced. A total of 144 articles were found, and applying the inclusion and exclusion criteria, 51 articles were obtained, as shown in Figure 1 (selection methodology diagram).

For the information search, the following keywords were used as keywords in the string:

- Scopus: "artificial intelligence" and autism and not teacher and not EEG and "autism bullying"
- IEEE Xplore: autism and "artificial intelligence" and no review.
- Web of Science: "artificial intelligence" and autism
- Science Direct: "artificial intelligence" and autism
- EBSCO: "artificial intelligence" and autism
- ProQuest: "artificial intelligence" and autism

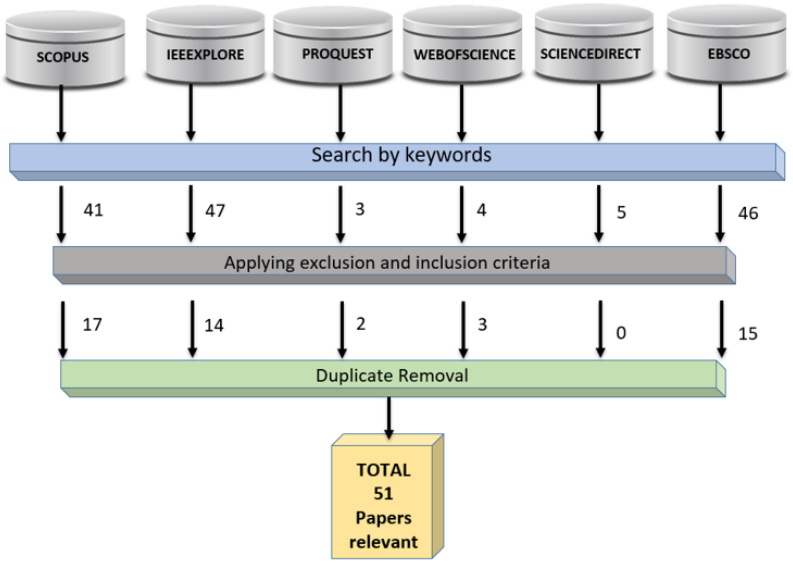

Figure 1. Selection methodology diagram

Three phases were carried out for the selection process of the studies collected. In the first stage, an initial search was made in the different databases; in the second stage, the titles and abstracts of 144 articles were reviewed, applying inclusion and exclusion criteria. The following inclusion and exclusion criteria were used for systematic review research, as shown in Table 1. Finally, in the last phase, 51 articles were selected for analysis and synthesis as shown in Figure 2. Bibliometric analysis allows us to extract literature by grouping and analyzing words that are usually grouped, which helps us to recognize patterns in the production of different authors. This technique facilitates the retrieval, evaluation, and statistical analysis of quantitative data from specific publications, useful for identifying research gaps and promoting collaboration in future studies.

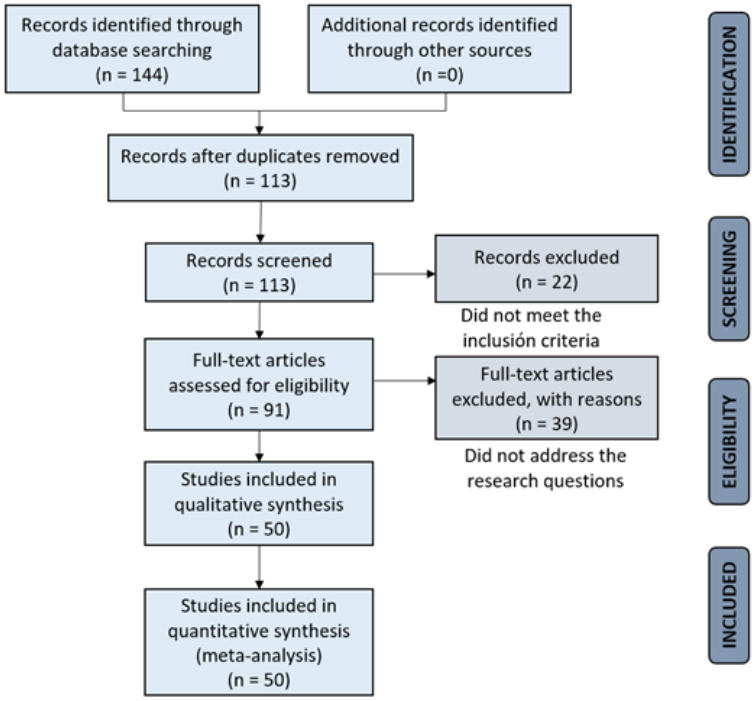

Figure 2. Prism diagram methodology

Table 1. Inclusion and exclusion criteria

	Criteria
Inclusion	Articles discussing tools integrated with artificial intelligence and support for people with autism. Articles mentioning types of software and hardware with artificial intelligence used in the diagnosis of people with autism. Articles in English and Spanish. Articles that are on the cutting edge concerning artificial intelligence and its diagnostic approach for people with autism.
Exclusion	Articles that are systematic reviews. Articles on diseases other than autism. Articles that are not related to the research responses. Articles that do not talk about mechatronic systems with artificial intelligence and their contribution to people with autism.

3. RESULTS

Figure 3 represents the number of articles found in the database analyzed by year of publication. The percentages of articles reviewed in each database were found, with the highest percentage being Scopus with 33% and the lowest percentage being ProQuest with 4% occurrences. Figure 4 reveals that, in the study, the black countries have the highest index of articles dedicated to research on the contributions of artificial intelligence in people with autism, in this case, India. On the other hand, the red countries are the ones with the least contributions in recent years, such as Brazil, the United Kingdom, and the United States.

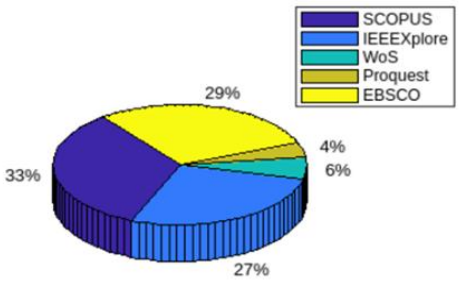

Figure 3. Articles sorted by database

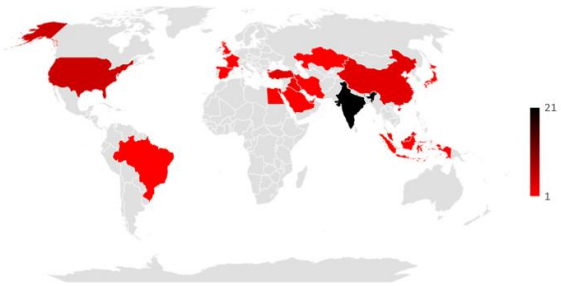

Figure 4. Articles analyzed by country

Elaborated using the VOSviewer tool [19], Figure 5 reveals a bibliographic network map on the topic of artificial intelligence and autism. Cluster 1 (red): with 14 items on autism in people; while cluster 2 (green): with 10 items related to machine learning and its application to people with autism. Cluster 3 (blue): with 10 items, they are related to early diagnostics and support victories, and the natural language processing system; and cluster 4 (yellow): the relationship of artificial intelligence to input in people with autism.

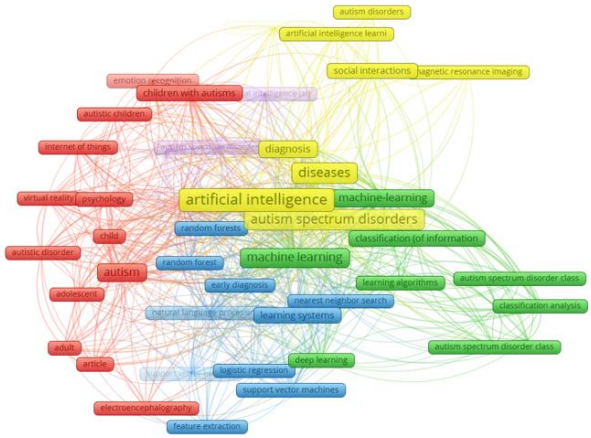

Figure 5. Bibliometric analysis overlay visualization

Figure 6 shows a word cloud as a result of the articles systematized by the R Studio software. In this bibliographic analysis, the most frequent words are autism spectrum disorder (ASD), explainable artificial intelligence, autism spectrum-based, artificial intelligence-based medicine, and artificial intelligence-based. Likewise, Figure 7 shows the most repeated words according to the analysis in a tree structure with their respective percentages, having 22% the word ASD, followed by 6% explainable artificial intelligence, and 3% based on spectrum disorder, and medicine based on artificial intelligence, and bases of artificial intelligence, both with 2% corroborating Figure 6.

Figure 6. Word cloud display of overlapping documents

Figure 7. Visualization of the documents based on bibliometric analysis

4. DISCUSSION

In this systematic literature review, we address the issue of the contribution of artificial intelligence to people with autism, collecting relevant and valuable information to help answer the questions posed.

4.1. RQ1: which artificial intelligence tools have been most used in recent years to improve the quality of life of people with autism?

Artificial intelligence improves the quality of life of people with autism through the use of various technologies, such as machine learning, which make it possible to identify patterns in data for earlier and more accurate diagnoses. Neural networks further enhance this capability by enabling applications that recognize emotions or facial expressions, thereby aiding social interaction. Additionally, fuzzy logic contributes by developing adaptive systems that tailor teaching or communication strategies to individual needs. Neural networks are used in applications that recognize emotions or facial expressions, facilitating social interaction. Fuzzy logic helps to develop adaptive systems that adjust teaching or communication strategies according to individual needs. In addition, technologies such as augmented reality and artificial intelligence improves-based virtual assistants create safe environments for practicing social skills.

Figure 8 shows the most used disciplines in the years 2022, 2023, and 2024; and highlights: machine learning with the highest number being 38, followed by natural language processing with 6, neural networks

with 3; and the lowest value in agent-based models, having only 1 and fuzzy logic. These advanced tools promote the autonomy, inclusion, and well-being of people with autism. Table 2 provides a more detailed visualization of the items and the different artificial intelligence tools offered when implementing them to improve the quality of life of people with autism.

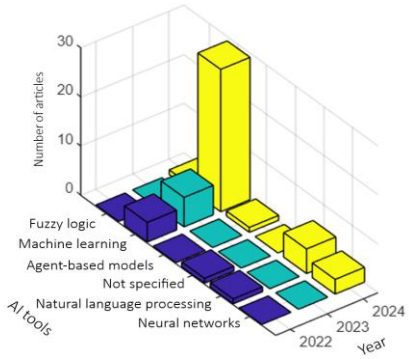

Figure 8. Articles analyzed with the most widely used artificial intelligence tools in recent years

Table 2. Articles classified according to the artificial intelligence tool used

Artificial intelligence tools	Quantity	Articles
Machine learning	38	[20]–[57]
Natural language processing	6	[58]–[63]
Neural networks	3	[64]–[66]
Fuzzy logic	1	[67]
Agent-based models	1	[68]

4.2. RQ2: what type of infrastructure has been most commonly used in the studies of people with autism using artificial intelligence?

Artificial intelligence significantly impacts various infrastructures by improving the quality of life of people with autism. Advanced processing enables the analysis of large volumes of data for more accurate diagnoses, while mobile devices integrate personalized applications to develop social and communication skills. The internet of things (IoT) facilitates real-time monitoring of behaviors and emotional states, providing alerts to caregivers. Virtual reality creates immersive and controlled environments to practice social interactions, and assistive robots act as therapeutic companions, adapting to individual needs. These technologies work together to promote autonomy and well-being. According to Figure 9, the most frequently used infrastructures are the processing infrastructures, and the least used is virtual reality, one with 34 and the other with only 1, respectively. Table 3 details which articles have used the different infrastructures in which artificial intelligence is implemented.

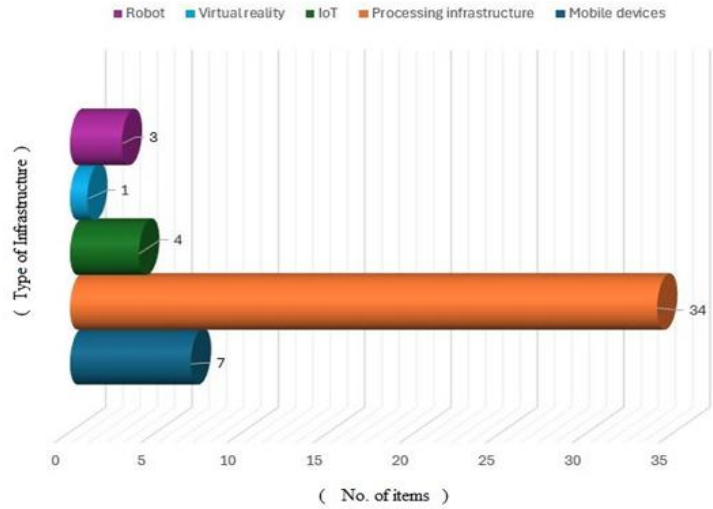

Figure 9. Graph of items grouped by type of infrastructure

Table 3. Classification by infrastructure used

Category	Quantity	Articles
Processing infrastructure	34	[22], [23], [25]–[29], [32]–[40], [43], [46]–[53], [57]–[62], [65], [67]
Mobile devices	7	[20], [30], [31], [42], [44]–[46]
IoT	4	[21], [54], [55], [68]
Robot	3	[41], [64], [69]
Virtual reality	1	[63]

4.3. RQ3: how can artificial intelligence improve the social, academic, and health lives of people with autism?

Taking into account the analysis of the articles, we can determine which area there is a greater chance of improvement in the lives of people with autism, through Figure 10. We can observe that health is the area where the application of artificial intelligence for the early diagnosis or treatment of autism has the greatest impact, in addition, there is an average approach in the social area; also taking into account the quality of life that covers several aspects and not just one specific one, on the other hand, there are still not many approaches in the academic part. Table 4 shows in detail in which aspects there is a greater focus on improving the lives of people with autism by making use of artificial intelligence.

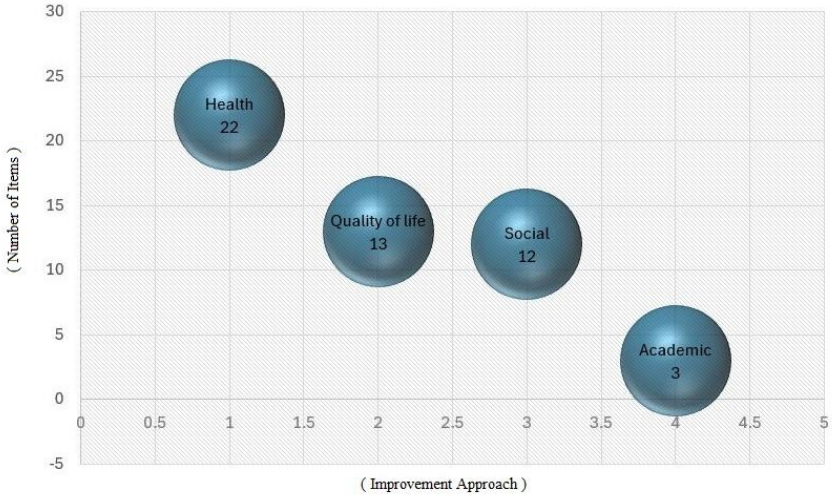

Figure 10. Number of items and their improvement approach

Table 4. Classification by infrastructure used

Approach	Improvement	Articles
Health	AI facilitates early and accurate diagnoses by analyzing data and behavioral patterns, while IoT devices enable real-time wellness monitoring. In addition, adaptive therapies based on fuzzy logic adjust interventions according to individual progress, optimizing results and reducing time.	[23], [24], [26]–[29], [31], [32], [34], [35], [42], [43], [46], [48], [49], [51], [55], [57], [61], [65]–[67]
Quality of life	Technologies such as robots and virtual assistants promote autonomy by supporting daily tasks, while augmented reality creates safe environments to practice skills. AI tools also help manage stress by interpreting emotions and providing appropriate responses in times of sensory overload.	[20], [21], [25], [36]–[40], [44], [47], [52]–[54]
Social	AI applications improve communication by translating expressions or gestures into words, and virtual reality allows practicing social interactions in controlled environments. These technologies foster inclusion by overcoming communication barriers and facilitating relationships in family, educational, and work contexts.	[22], [30], [41], [45], [56], [58], [60], [62]–[64], [68], [69]
Academic	AI-based educational platforms personalize content according to learning style and pace, fostering understanding and progress. In addition, intelligent tools help maintain focus and provide educators with data and recommendations to design more effective strategies.	[33], [50], [59]

4.4. RQ4: which countries are most actively implementing artificial intelligence for social and emotional development in people with autism?

To answer this question, we first look at Figure 11, which provides information on the number of documents analyzed by country from 2022 to 2024. While it is true that in 2024 there will be a greater number of

articles related to artificial intelligence and its focus on people with autism (see Figure 11), we can also observe that India is the country with the highest number of publications on these articles. However, approximately 50% of these articles have been applied and others are under research; Figure 12 shows the countries that have most actively applied intelligence to help people with autism and it can be seen that India and the United States are countries that, as technology advances, are actively researching and implementing different disciplines of artificial intelligence to improve daily aspects of the lives of people with this type of disorder.

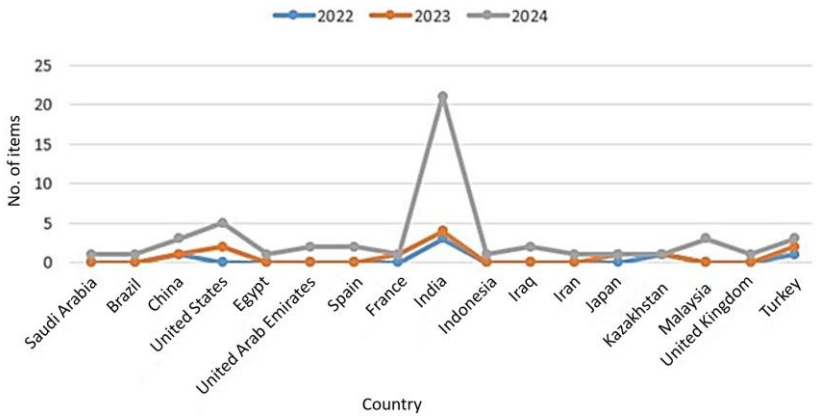

Figure 11. Articles analyzed by country for the last 3 years

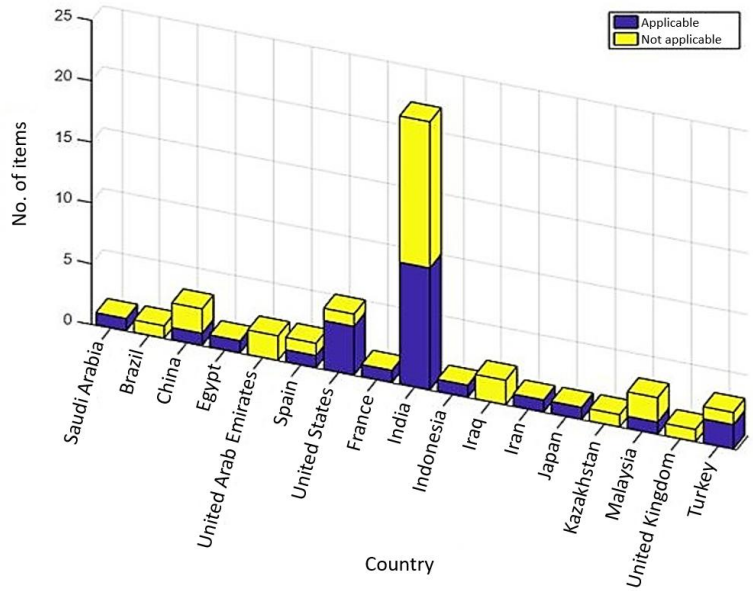

Figure 12. Articles grouped by country that apply artificial intelligence in their approach to people with autism

4.5. Related articles

Other review studies, such as [70], based on the role of artificial intelligence in the early detection of ASD, in comparison to our systematic literature review, managed to identify 2,720 articles of which they synthesized 35 that included studies on behavior-based ASD diagnosis and screening published in PubMed, Scopus, IEEE Xplore database; their focus was children aged 6 years; this study oriented directly on the application of artificial intelligence such as machine learning and deep learning; suggests that technology can improve early diagnosis bringing benefits in improving the quality of life in people with autism. In addition, the following systematic literature review [71] also focused on the importance of technological tools such as artificial intelligence and their potential to improve understanding and support for people with autism; in this study, they filtered 20 publications out of 391 using the PRISMA method. The study refers to artificial intelligence as a means by which it improves the relationship between therapist and patient, through analyses that show the affective state of people with autism to facilitate communication and improve rehabilitation

treatments through personalized interventions. This review, together with ours, provides us with an overview of current studies and how artificial intelligence manages to play an important role in making a positive contribution to different areas of life for people with this disorder.

5. CONCLUSION

Artificial intelligence is being implemented in health and is taking on a very important role, for example, in providing earlier and more accurate diagnoses; likewise, it is being used to improve everyday aspects of social and academic integration or simply in a general area of quality of life in people with autism. In addition, most articles show a preference for machine learning when implementing artificial intelligence in different types of implementation applications, and this is due to its ramifications since it has a very good capacity to learn from data, automate tasks, prediction and analysis, adaptability, continuous improvement, complex problem solving, human-computer interaction, and its versatility; thus, allowing significant advances in different applications. The type of processing infrastructure covers CPUs and GPUs, which are fundamental to the operation of a modern computer and tend to have a leading role in the articles synthesized because machine learning is the type of artificial intelligence used; and this is because the field with greater relevance is the health and need computers that can process large volumes of data in parallel, and be suitable for the use of deep learning a type of branching of machine learning that uses complex neural networks. Likewise, it is concluded that Asia is the continent that has most research from 2022 to 2024, related to artificial intelligence and its different contributions to people with autism, being India the one that is at the forefront, although only about 50% of their studies have been applied, and these results when comparing the number of articles per country is rooted to the fact that it is the most populous country in the world. Finally, we know that artificial intelligence is a useful tool that has a positive contribution; it is being implemented with greater force in all possible areas, and its contribution to people with autism has served to improve the quality of their health, their interaction with society, and their acceptance by it, as well as facilitating academic learning.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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Anderson Moza-Villalobos	✓	✓	✓			✓	✓		✓					
Michael Cabanillas-Carbonell				✓	✓			✓		✓	✓	✓	✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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