Research Article

Global Trends in Rehabilitation of Autism Spectrum Disorder: A Bibliometric Analysis

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Abstract

The study employs a bibliometric analysis of 238 peer-reviewed publications from Scopus, from the year 2015 to 2025 for studying the research trends, understanding the conceptual gaps and propose future direction for research on autism spectrum disorder. The increase in scientific publications, especially in 2024 to 2025, reveals growing interdisciplinary attention towards autism spectrum disorder, developmental disabilities and neurodiversity. The keyword analysis shows that Autism, Autism spectrum disorder, ASD and children are the main topics of research. Despite this, the inconsistent presentation and variation in the keyword's usage shows that there is the urgent need of uniformity and cross study synthesis.

Additionally, the analysis reveals new themes that indicate a variety of intervention strategies, including physical activities, problem behavior, occupational therapy, telehealth and social skills. Interestingly the words like "interventions," "functional analysis" and functional communication training indicated increasing emphases on behavioral and therapeutic approaches. However, less common words like phenomenology, obesity and distress point out psychological and systemic aspects of autism that haven't been studied enough and need to be looked into more in future research.

The journal of development and physical disability has the most articles published, followed by scientific reports, Heliyon and the American journal of Occupational Therapy. This shows that people tend to publish articles in their own field. The clustering facilitates concentrated discourse, which unintentionally obstructs interdisciplinary integration.

Still certain noticeable gaps, persists such as inadequate research studies on adults with ASD, intersection of gender and neurodiversity and cross-cultural viewpoint. Furthermore, despite the potential to improve access to care of people with ASD. Technological advancements like telehealth are still underutilized. In conclusion, the bibliometric analysis points to the need of interdisciplinary collaborations, more terminological consistency and inclusive, lifespan oriented and tech integrated framework to expand ASD research agendas.

Keywords: Autism Spectrum Disorder (ASD); Rehabilitation; Bibliometric Analysis; Therapeutic Interventions; Occupational Therapy; Physical Activity; Sensory Integration; Behavioral Therapy; Telehealth; Social Skills; Neurodevelopmental Disorders; VOS viewer.

1. Introduction

Autism spectrum disorder is a complex neurodevelopmental disorder that usually manifest in early childhood and is characterized by poor eye contact while communicating, repetitive behavior, communication difficulties and difficulty in social interactions. Over the last 20 year the ASD have significantly increased worldwide, which has also led to increased curiosity of research in the etiology, assessment and intervention strategies of ASD globally. Consequently, the literature base on ASD has expanded considerably, requiring systematic methods like bibliometric analysis to identify knowledge gaps, synthesize important trends and guide future research. [1]

Bibliometric analysis offers a quantitative assessment of scientific output, illustrating the intellectual framework of an area of research and highlighting significant themes, authors, instructional and collaborative networks. In recent years, this analysis has been beneficial in evaluating various therapeutic techniques, including collaborating arts therapies .Utilizing a comparable methodology in ASD research facilitates the recognition of shift in focus from diagnosis and classification towards interventional efficacy, early screening, technology-assisted support and interdisciplinary approaches. [1]

A systemic review looked at how well Ayers Sensory Integration worked compared to other sensory-based therapies for improving participation outcomes for children with ASD. These findings indicated that adherence to the Ayres

model produces significant improvement, emphasizing the need for intervention models rooted in evidence and theory. [2]

An extensive bibliometric analysis of global ASD showed that after 2005, exponential growth in ASD research output after 2005, with high contribution from North America and Western Europe. The previous literature demonstrates that researchers has shown more focus towards early detection of ASD.[3] A study confirmed the effectiveness of extensive eye tracking techniques as indicators for early ASD diagnosis. It focused on the clinical use of machine learning and computer vision in rehabilitation. All these new findings depicts a turning point in the diagnosis of Autism by improving the conventional evaluation tools using new technologies. [4]

Another study discussed use of various mobile technologies that could be used to help teach children in schools and usefulness of these technologies in special education. The study compared teacher-led and iPad-assisted lessons for kids with ASD and concluded that use of digital devices makes students more interested and also helps them do better in school.[5]

The professionals are also inclined towards motor behavior of children with ASD. A research study showed comparison of the gait pattern of children with ASD to typically growing children. The findings of the study reveled a big difference in the movements of the lower limbs, which suggests motor problems that otherwise aren't the main diagnosis criteria but could be a good sign for early screening. [6] Many studies are focused on the social behaviour and how people connect with each other. Studies aims to improve how students connect with each other in school. [7]

Researchers worked on developing and testing a machine-learning models that use behavioral traits to sort ASD cases into different groups. Their models helped the field of medical tools that use AI to develop very sensitive, and accurate tools. These tools will be useful for doctors, specifically in places with few means. [8] In a study on the eating habits of kids with ASD, Kim et al. Found mineral deficiencies, mainly with calcium and vitamin D. The study's results show that nutrition isn't getting enough attention and stress how important it is to include food treatments in complete care plans. [9]

Majority of people are using online health care after COVID-19, this shows that use of tele-interventions is becoming common nowadays. Many researches focus on observing how the reactions of the parents influences language development of their toddlers who have ASD. Active parental involvement improves expressive vocabulary and highlight the importance of family centered therapeutic approaches. [10, 11]

A systematic review and meta-analysis done previously demonstrated a large interregional and inter age differences. It shows difference in identification and perception of people across countries. [12] In addition, music therapies are gaining popularity now days. Previous research in a controlled setting showed how music therapy affected brain function and interpersonal relationships between kids with ASD. The results revealed that children with ASD had increased social communication and reformed functional connections in the brain areas associated with auditory motor integration. [13]Another study of environmental risk factors found a link between mothers who were exposed to air pollution from cars and their children being diagnosed with ASD. This is consistent with the theory of an environmental trigger for autism. [14]

In addition, studies has investigated to show that how individuals with ASD perceive visual information and process sensory input. The results indicated that increased sensitivity to sensory stimuli is a prominent feature of ASD. This highlights the importance of the needs of including this during diagnosis and treatment. [15]

The article includes studies that includes a wide range of topics in ASD research, which includes neuroscience, education, family support, public health, nutrition, and technology. In addition, other Interdisciplinary methods like eye tracking, movement analysis, and machine learning are becoming more popular. This illustrates that the field is moving towards more modified and integrated explanations. The current study of bibliometric looks at the patterns by looking at the author of the paper, keywords they used, institutions they were affiliated with, and how they were cited in the ASD literature in the Scopus index. [1,16] This study aims to pinpoint emerging research gaps and propose actionable future directions.

2. Methodology

2.1 Search Strategy and Data Source

The present bibliometric analysis focusing on trends in techniques used for the management of children with ASD is based on the research papers indexed from the scopus database. The research papers are chosen due to its

comprehensive listing of peer reviewed journals across several disciplines and its appropriateness for bibliometric analysis. A systematic research was performed utilizing the terms “Autism spectrum disorder,” ”ASD,” and “children with Autism,” in conjunction with keywords such as “rehabilitation,” “therapy,” “intervention,” and “management.” The period was limited from 2015 to 2025 and only including articles published in English, with the focus on their combinations in the title, abstract and keywords in peer-reviewed journals were included for analysis. The applied Boolean search query was (“autism” OR “autism spectrum disorder OR “ASD” AND (“rehabilitation” OR “therapy” OR “intervention” OR “treatment” OR “physical activity” OR “occupational therapy”)

2.2 Inclusion and Exclusion criteria

Inclusion Criteria:

- Articles Published between 2015 and 2025.
- Original research papers that have been peer- reviewed.
- Focus on interventions, therapies or rehabilitation of people with ASD.
- Listed in Scopus database

Exclusion Criteria:

- Articles published in any other language other than English.
- Conference abstracts, reviews, editorials and sources that are not journals.
- Articles focusing solely on animal models or genetics.

2.3 PRISMA Framework

The PRISMA guidelines were framed to increase the transparency and methodological accuracy in the selection of articles. We started with 2285 total papers, duplicate papers were checked and removed, and the articles were then screened through titles, abstracts and full text of the articles to see if they were relevant and eligible.

2.4 Data extraction and analysis

The data files of the selected 238 articles were extracted and organized using Microsoft excel and bibliometric mapping and visualization was conducted using VOSveiwer. Bibliometric information included title, author keywords, citation of paper by count and DOI was exported in csv format from Scopus. Data cleaning was performed using Microsoft excel and open refine to correct inconsistencies in author and institutional names, remove duplicates and standardize keywords (e.g., ”ASD” vs. “Autism spectrum disorder”).

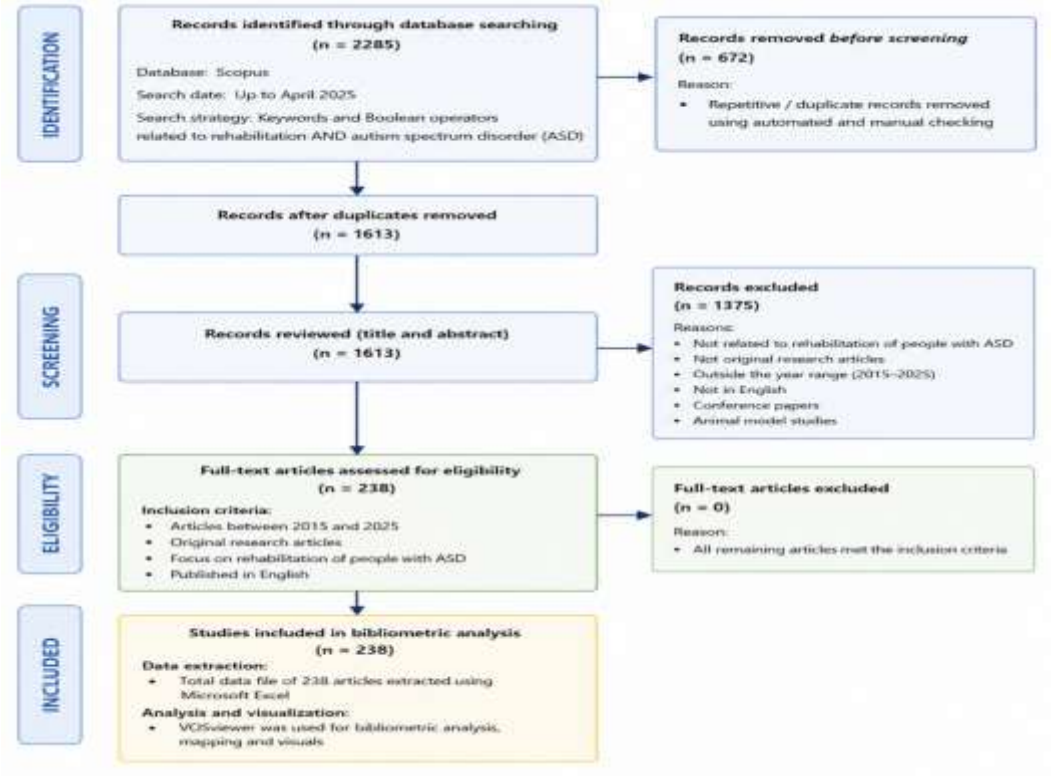


Fig. 1. Consort Diagram

2.5 Analytical tool and technique

The filtered dataset was imported into VOSveiwer (version 1.6.20) a software tool specifically made for building and visualizing bibliometric networks. Multiple analysis were done like:

Co- citation Analysis: Used to identify important publications and to map the intellectual structure of research on interventions for Autism spectrum disorder.

Keyword co-occurrence analysis: Found terms that were used a lot and groups of relevant terms that were used a lot in database, showing new and important research themes.

Co-authorship collaboration: Studied the network of co-authors to find patterns of collaborations and links between institutions.[26]

Bibliographic coupling: to find the shared references between articles and journals.

Overlay Visualization: shows changes overtime and new areas of research.

3. Results

3.1 Publication Trends and geographic distribution

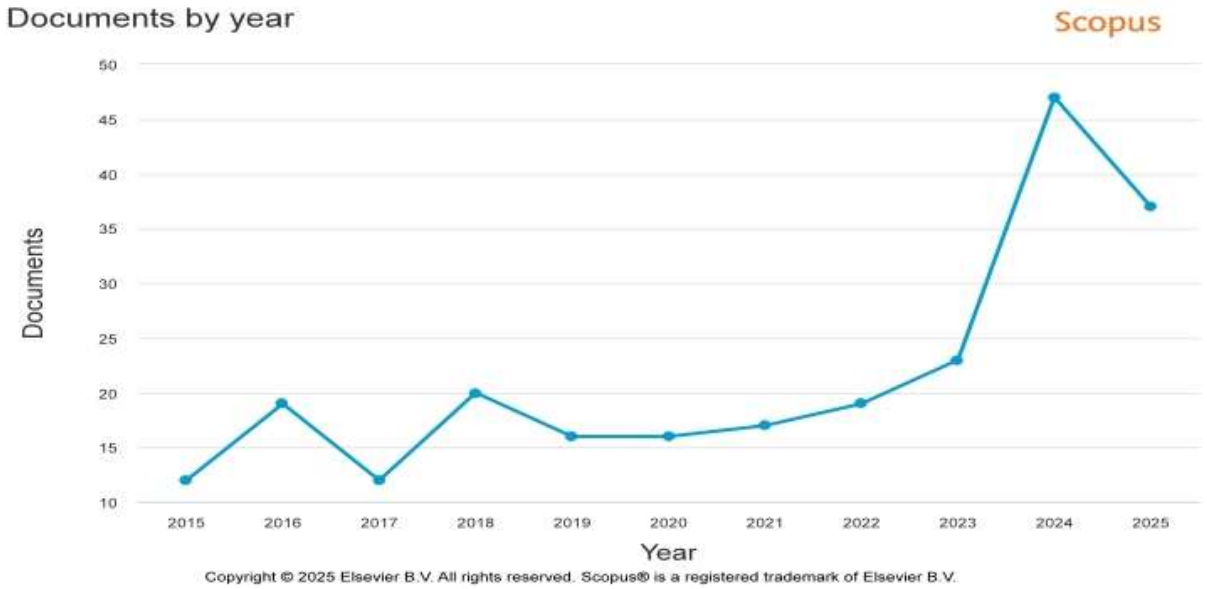


Fig. 2. Annual trend in publication of rehabilitation for Autism spectrum disorder

The Figure 2 reflects the overall upward growing body of literature in the global research domain rehabilitation for Autism spectrum disorder from 2015 to 2025. It demonstrate remarkable growth in the last decade. There is a distinct upward trajectory in publication rate from 2015 to 2025, spiking in the year 2024. The enormous rise in 2024 indicates spike of researcher's interest in this discipline.

From 2015 to 2018 is the period of fluctuation. Publications varies from 13 to 21 papers every year. The initial increase in the publication was seen , with less than 20 paper published in the year 2016 followed by a dip to 13 papers in 2017.A bounce back is seen in 2018, with the total publication of 21 papers which marks as the highest in 2015 to 2018. The period from 2019 to 2022 shows a plateau phase with gradual growth with minor variations between 16 to 18 papers in a year. A significant increase in the number of articles was seen from 22 in 2023 to 47 in 2024 which was more than double the number in previous years. This phase illustrates a enormous spike in research production that could possibly be due to budding interest, funding global concern of the topic. A slight decline to 38 papers is seen in 2025, which is still higher that the papers published in 2024. Probably as the year is still progressing.

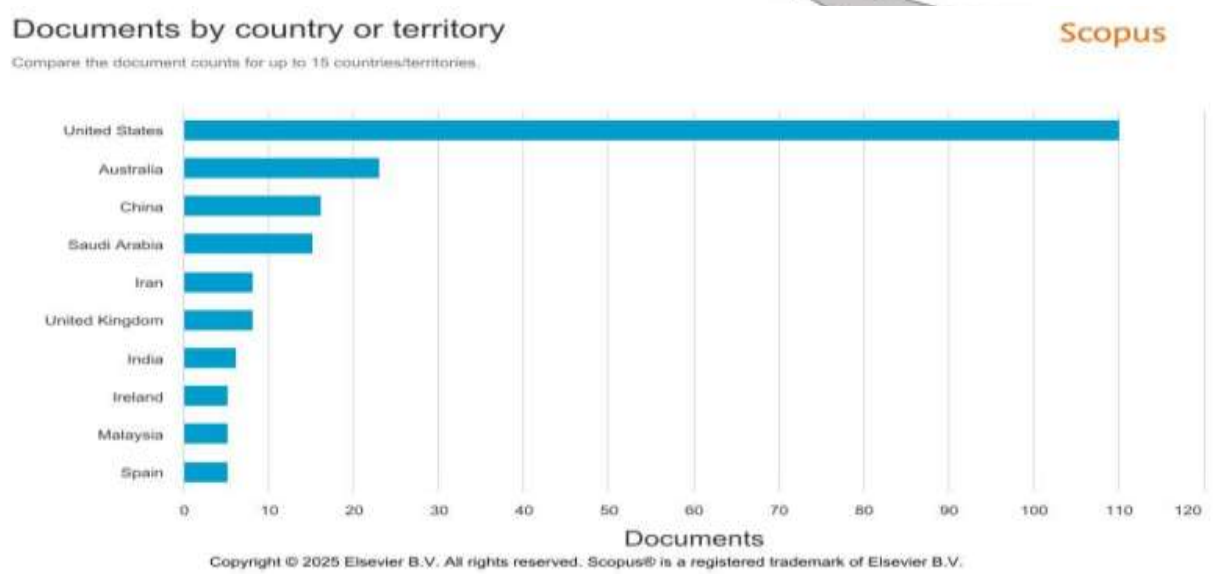


Figure. 3. Distribution of research publications according to country.

The figure 3 illustrates the country wise distribution of the research papers in the period 2015 to 2025. Altogether, the Scopus database comprises of publications from over 62 countries of origin. The top three countries with the highest number of publications were United States shows the highest number of publications (110 publications) followed by Australia (22 publications) and China (18 publications). Saudi Arabia is very close to China with 15 papers. Iran United Kingdom, India, Ireland, Malaysia, Spain contribute around 8 to 10 papers each. The United States shows significant research contribution, which probably reflects more research funding, academic engagement and focus on growing concerns. India's contribution towards research on rehabilitation of children with ASD is lower in comparison to the western countries. India's low participation may possibly be because of less interest of researchers in this area of research, limited access to Scopus indexed journals, Fewer international collaborations and gap in research funding and infrastructure disparities.

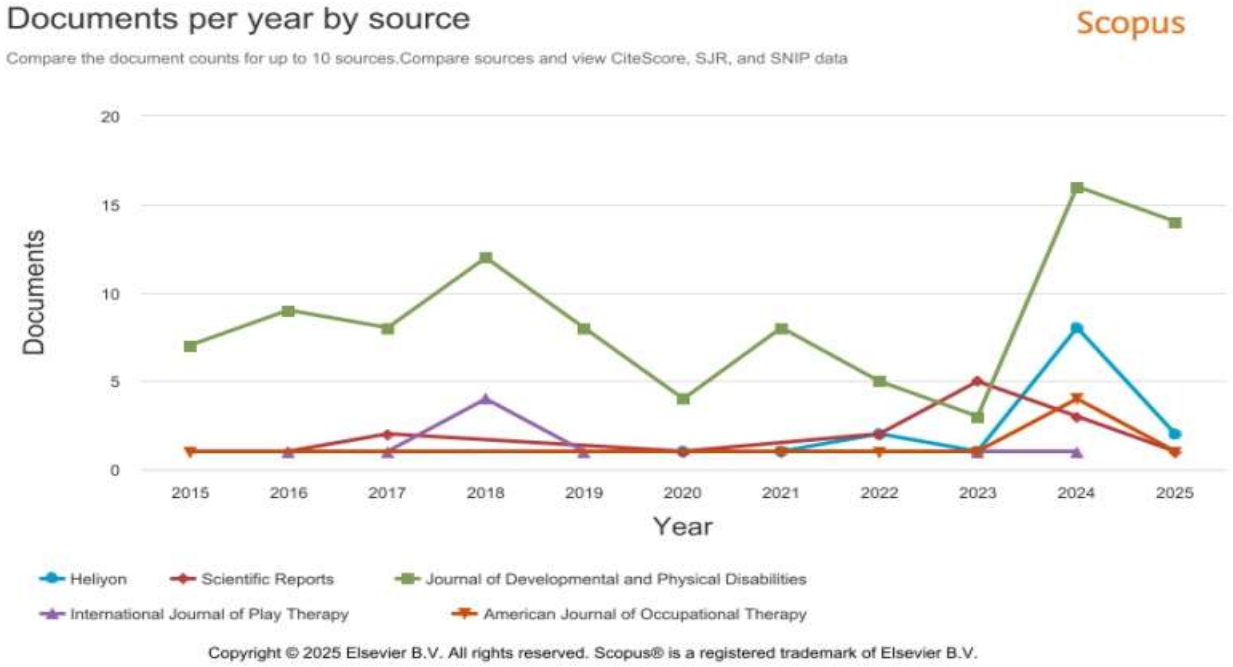


Figure.4. Annual research publications by source

The above figure 4 shows the publication trends over time from 2015 to 2015. The journal of developmental and physical disability (USA) has most publications especially in 2024. The second highest publications on rehabilitation in Autism spectrum disorders is seen in UK based open access journal Helion. It began publishing papers around 2021 and the highest papers were published in the year 2024. Another journal from USA, American journal of occupational therapy showed a consistent increase especially in 2024. This indicated that occupational therapy is becoming greater part of autism treatment. The International journal of Play therapy (USA), on the other hand had more papers in 2018 and less after that. Probably because they have lost interest in the topic. Overall year 2024 showed increased number of publications, which depicts that more people are interested in autism research. More journals are based in USA, interest if UK is increasing. The India has no position in this field.

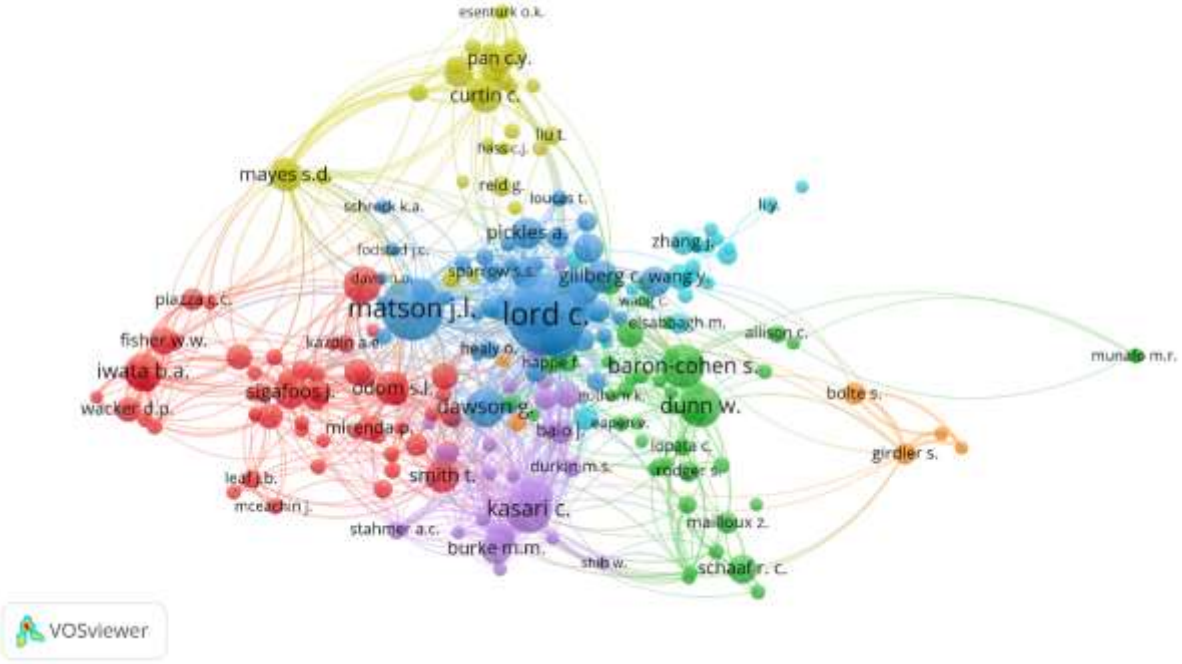


Figure.5. Visualization map depicts Author Citation linkage analysis

The figure 5 highlights the co-citation network of the prominent authors based on the academic literature citation. It demonstrates the intellectual framework and influence of key authors in the field of Autism spectrum disorder.
The figure depicts a series of interconnected groups, with each set containing various, but interconnected, aspects of Autism spectrum disorder (ASD) research that are relevant to each. The blue cluster which includes, Lord C., Matson J.L., Gill berg C., and Pickles A., is the intellectual core of the field. It has contributed significantly to the development of the diagnostic process, developmental pathways and early intervention strategies. They are placed centrally suggesting that they are a very important element that is cited with other various fields of ASD research. The red cluster, representing the work of Iwata B.A., Sigafoos J. and Fisher W.W., is well representative of the tradition of applied behavior analysis, treatment models of behavior and functional assessment techniques, and is a close association of researchers. It was Baron-Cohen S., Dunn W., and Schaaf R.C. who were in the green cluster. This demonstrated the significance of cognitive and sensory views in the context of the theory of mind, sensory integration and neurodiversity. The other yellow cluster highlights emerging directions, directed by Pan C.Y. and Curtin C. in the categories of Physical activity, Health and related co-morbidities. It reveals an increased awareness of a 'whole person' approach to ASD. The following is the purple cluster , which is contributions from Kasari C., Smith T., and burke M.M., stresses inclusive education, innovative interventions and the active role of parents in the therapeutic interventions. The purple cluster, led by Bolte S and Girdler S, is more peripheral, focusing on a number of themes including occupational therapy, gender diversity and cross-cultural perspectives, demonstrating the development of this field. As a whole, the author's co-citation analysis indicates that there are indeed strong academic communities, and also strong indications of the need of better collaboration between fields.

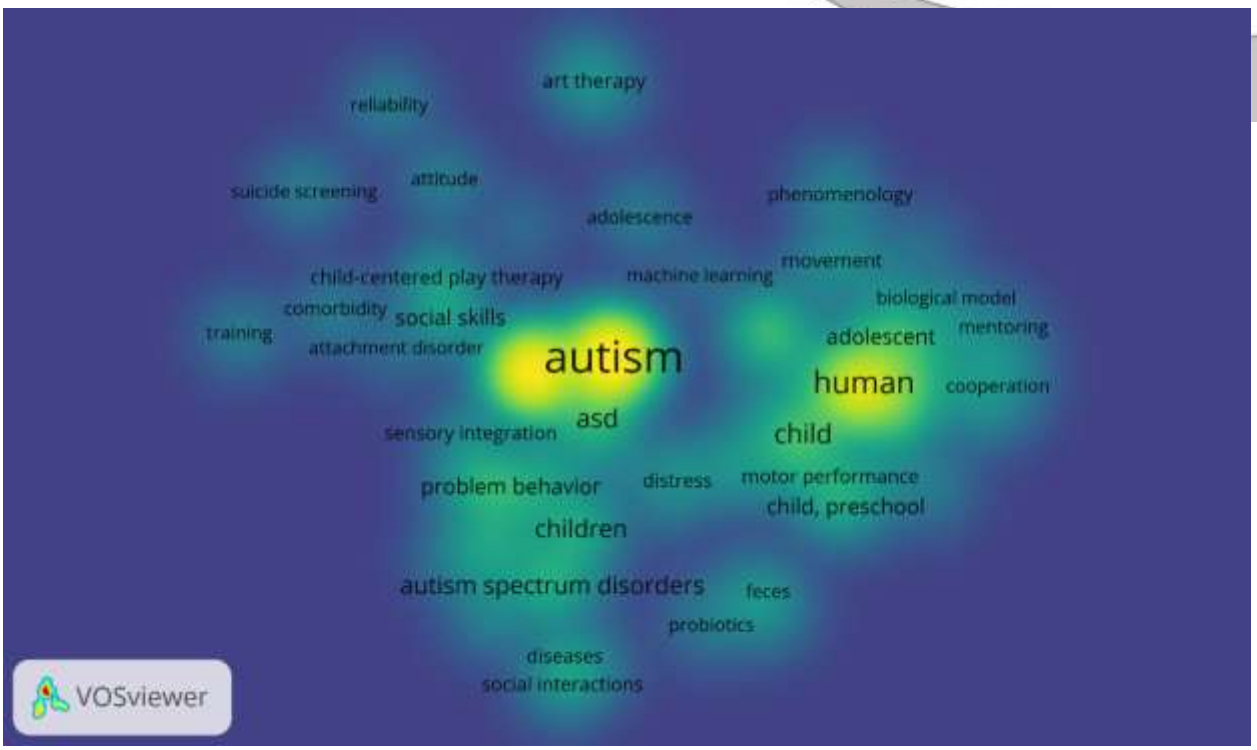


Figure.6. Density visualization of keyword co-occurrence.

The figure 6 depicts the keyword co-occurrence density analysis provides insight into the conceptual structure and evolving directions of autism spectrum disorder (ASD) research. The density visualization map shows areas of different intensity, which shows how often and how closely, related keywords are in the literature

The yellow areas with the high density shows the most prevalent themes. The most frequently word used “Autism” and “ASD” anchor the entire research. The keywords like “human,”” Child,” and “children” shows that most studies are focused on pediatrics and development. The other main themes includes “social skills,” “Sensory integration,” “ Social interaction,” “Problem behaviour,” shows the ongoing interest of people in behaviour, development and diagnostic aspect of ASD.

The green area with medium density shows where research is growing. The word “Adolescent,” “Motor performance,” and “distress” shows that more people are interested in adolescent and challenges of motor and emotional regulation. The words like “child centered play therapy,” “ attachment disorder,” and “ Training” shows that people are moving towards more holistic, therapeutic methods. The keyword “Machine learning” indicates that artificial intelligence will be used in diagnostic and data analysis in the future.

Low-density areas, like the blue and purple areas, show unexplored areas. These includes keywords like "Suicide screening," "Comorbidity," "Probiotics," "Faeces," and "Comorbidities." Researchers are still working on the biology model of ASD, gut-brain connection, mental health problems, and microbiome. These are few areas where more research is required.

The map also displays the multidisciplinary approach of ASD. The topics part includes cognitive and behavioural sciences, medical and biological areas, technology and new ideas, mental health, and therapy approaches. These numbers show how far modern study has come and how easily different fields can work together.

Overall, the study shows that most mail about ASD studies is about behaviour, social skills, and different ways to help kids. Recently, people have become more interested in biological advances, computer tools, and mental health issues. Poorly studied areas that hold a lot of potential for future work together and finding include adult results, conditions, and working together across different fields.

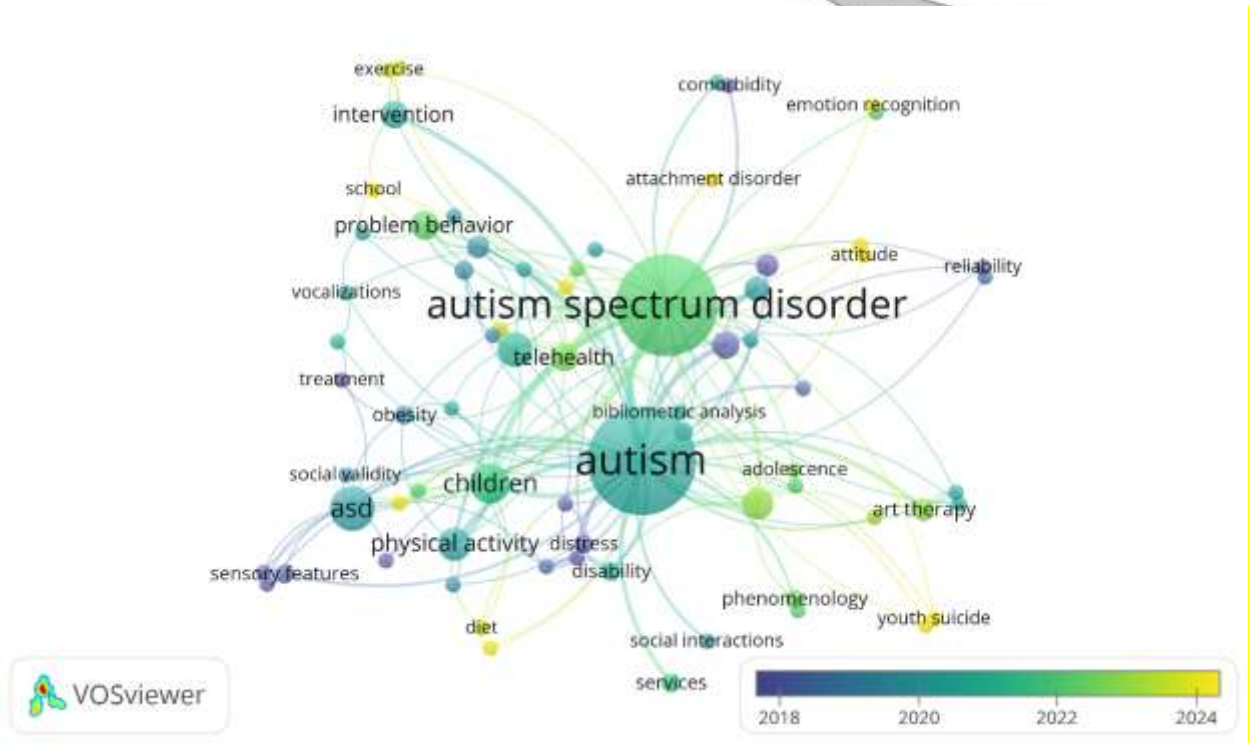


Figure. 7. Co-occurrence of Author Keywords

Overlapping visualization reveals the alteration of study themes in autism spectrum disorder by analyzing the frequency of co-occurrence of author's keywords. The colour coding of the graphic elucidates change over the years: older topics from 2018 are shown in blue and purple. Green themes depicts the middle of their development cycle for the 2020-2022 period and yellow regions are areas beginning to be developed for the 2023-2044 period. The network comprises certain high frequency nodes that are in the middle of the network like "children," "autism spectrum disorder," and "ASD.

These are the essential concepts in the field, learned for many years, and closely related to numerous other fields. Stability and change also are indicated on the map through theme groups. Blue/Green Nodes represent Core & Established Areas. Keywords in these areas include "social validity," "sensory features," "obesity," "treatment," and "distress," which are common issues in behavioral, diagnostic, and clinical research. In the middle of the era, the green theme shows how fields like "disability," "adolescence," "art therapy," and "telehealth" are growing. This indicates increasing attention on lifestyle, new therapies, and virtual care models. Telehealth is particularly becoming a recent study area. “Emotional recognition,” “youth suicide,” “exercise,” “diet,” “intervention,” and “attachment disorder” are some of the new topics that have been created recently depicted in yellow. These shows the new research frontiers focusing on neurocognitive processes, mental health problem, and wellness-oriented approaches.

Structurally, the network shows strong interconnection, which shows a strong interdisciplinary approach. Although much of the research is still clustered around core clinical and behavior themes, but there are also new areas of research in public health, education and technology facilitated care. There is also a rising interest in policy oriented, and system based research.

As a whole, the visualization shows strong chronological drift in academic research on ASD. The latest researches is evolving from its traditional focus on diagnostic and therapeutic interventions towards broader concerns towards bigger concerns like technology, emotional well-being, lifestyle and social context. These findings emphasize the importance of integrated, individualized research in autism. For both researchers and policymakers, such findings are valuable in identifying new priorities, direct opportunities for research funding, and form collaborations that can shape the future of ASD studies.

For both researchers and policymakers, those findings offer important guidance to identify new priorities, direct opportunities for research funding, and form partnerships that can inform the future of studies on ASD.

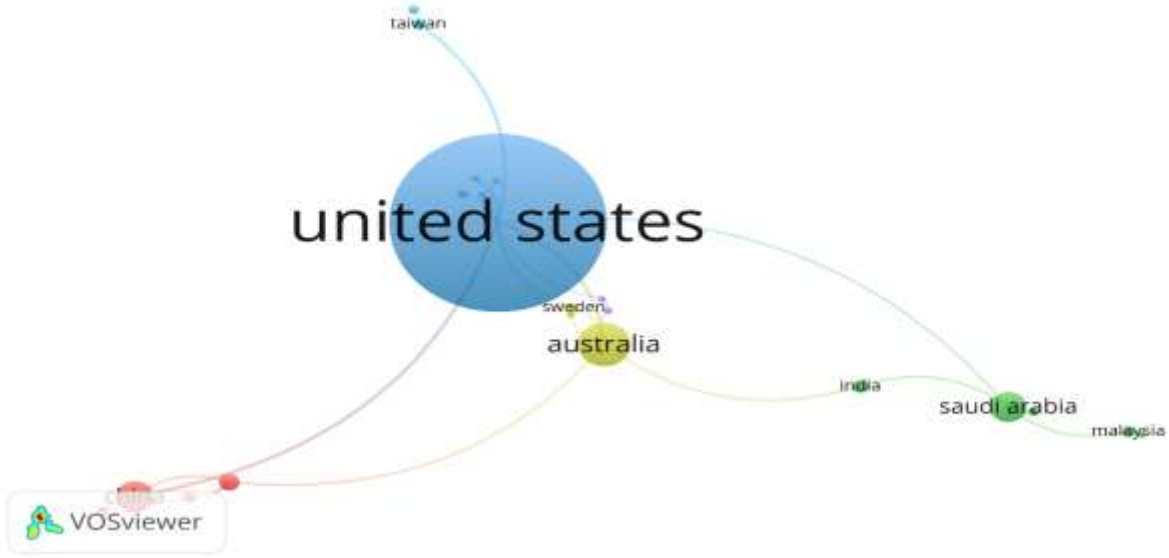


Figure.8. Co-authorship Network Visualization between Countries

The figure 8 shows the network visualization illustrates international co-authorship patterns in autism spectrum disorder (ASD) research, where each node represents a country and its size reflects publication volume, while the connecting lines indicate the strength of collaborative ties.

Among them, the US is the most noticeable with as apparent larger size of node and more powerful connections around the region. This demonstrates that how wide its research facilities, funding capacities and collaboration in ASD research.

Australia and Saudi Arabia identified as important secondary nodes and act as important regional collaborators. The Australia have a good relationship with U.S, Sweden, Saudi Arabia and China, forming a link between the west and the east organisations. Saudi Arabia, despite this show some relations with India, Malaysia and U.S .The position of S is showing development. The smaller point in the graph represents countries such as China, India, Malaysia, Sweden and Taiwan. They indicate that the connections are less robust, fewer publications exist, and there is less international participation. China is conjoining with the U.S. and Australia, but in a limited fashion, on the outer fringes. These trends also highlight the issues that need to be addressed, including lack of funding, policy barriers, and language barriers that impede the ability to collaborate more effectively.

Discussion

The distribution of publications over time demonstrates an improving trend in study in this area over the past ten years. The number of publications went up and down a bit from 2015 to 2018, which shows that this was a first study/exploration. The situation was rather steady from 2019 to 2022. Work performed remained unchanged or slightly increased. This may be the result of methods being better or that themes from early in the season were getting too popular. The most interesting part of the graph is the rapid increase beginning in 2023 and reaching its peak in 2024. This rise shows that people all over the world are interested again, possibly because of differences in society, new lawmaking, or new tools and procedures. The slight decline in 2025 should not be seen as significant, as the real reason behind this decline is the delay in tracking for the academic output than a genuine drop. The country-by-country spread results are surprising as it reveals the working of study around the globe. More than fifty percent of all journals are in the United States, giving them the upper hand. In the past, it has done many researches in health sciences and has many contacts at different academic organizations, and can get funding from high-level funding programs. Next to the United States, Australia, China, and Saudi Arabia are the next most significant donors. Australia has a strong influence because of its busy academic institutions and the government funds for health

studies. Now, China and Saudi Arabia are the emerging centers. This shows that there is a rise in interest in scientific studies and scholarship is becoming increasing 'internationally' in recent years.

Further countries that have joined include Iran, the UK, India, Ireland, Malaysia and Spain. This indicates opportunity and challenges. They do not have as big output as that of the top countries, but it is indicated that there is an increased awareness in study across the globe. The Middle Eastern countries is gaining increasing recognition in other parts of the world, such as Iran and Saudi Arabia. Though they are still new, these new projects could bring in culturally different points studying the realization of these concepts in image and world proof.

The way that publications are spread out over time shows how study in this area has been getting better over the past ten years. The number of publications went up and down a bit from 2015 to 2018, which shows that this was the beginning of study and exploration. Things were stable from 2019 to 2022. The amount of work done stayed the same or barely increased. This could mean that methods were getting better or that early themes were becoming too popular.

When you look at the graph, the sharp rise that starts in 2023 and peaks in 2024 is the most interesting. This rise shows that people all over the world are interested again, possibly because of changes in society, new rules and laws, or new tools and techniques. You should not put too much stock in the small drop in 2025; it's more likely to be due to delays in tracking than a real drop in academic output.

The country-by-country spread is a big surprise because it shows how study works around the world. Over fifty percent of all journals are in the United States, giving them the upper hand. In the past, it has invested in health sciences study for a long time, has a lot of contacts at different academic institutions, and can get money from high-level funding programs. This power not only shows how much can be done, but it also changes the world study goal and tends to set the themes that can be seen. After the United States, Australia, China, and Saudi Arabia are the next most important donors. One reason Australia has a strong influence is that it has busy academic institutions and the government funds health studies. At the moment, China and Saudi Arabia are the emerging centres. This shows that scholars are becoming more interested in scientific study and that scholarship is becoming more global in recent years.

Iran, the UK, India, Ireland, Malaysia, and Spain are among the other countries that have joined. This shows that there are both possibilities and obstacles. Their output isn't as big as that of the top countries, but it shows that people all over the world are becoming more interested in study. India is a good example of a country that is important but not well known enough, even though it has a lot of people and needs data and programs that are specific to the area. In the same way, the contributions from Middle Eastern countries like Iran and Saudi Arabia show that this field of study is becoming more well known in places where it wasn't before. Though they are still pretty new, these new projects could bring in culturally different points of view and world proof.

Meanwhile, the unequal contribution in the world is a subject of concern. The fact that so few major nations control so much of the discourse implies that a big portion of the discussion is influenced by Western models, which cannot always be applicable to other cultures. The minimization of representative representation of the countries of the Global South, such as Africa, South Asia, and Latin America, is indicative of the structural obstacles, such as insufficient funding, absence of specialized training, and lesser global partnerships. It is important to tackle these imbalances to have a more balanced and context-specific knowledge base.

The other notable detail is the possibility of improvement of cross-border collaboration. Although the presented data represent the locations of the production of the greatest number of research, they do not always reflect the level of international collaboration. Fostering collaboration between high-production countries and underserved areas can help speed up the capacity-building process and the transfer of knowledge, as well as diversify the source of views that guide research priorities in the world. Moreover, cross-regional research would be a way of covering the themes that are still under-researched, including cross-cultural differences in diagnosis and treatment, or the specificity of healthcare systems under resource constraints.

Altogether, the tendencies of publication and the geographical distributions indicate positive developments and urgent gaps. The recent increase in production is associated with the increasing awareness and the prioritization of this area of research. Nonetheless, the geographic clustering of the publications suggests that conscious efforts should be made to expand the involvement, increase inclusivity, and make the research results relevant to the populations and contexts of a wide variety.

Conclusion

The authors draw attention to the swift increase of Autism Spectrum Disorder (ASD) rehabilitation research over the last period, and especially in the years 2023 and 2024. The results provide clear indication of the growing global attention in the field that has been driven by the progresses in research methodology, policy initiatives and funding opportunities. Regardless of the developments, research activity is not evenly distributed; the United States is the major source of yield and influence, and countries like Australia, China, Saudi Arabia, India, Iran, Malaysia, and Spain are becoming imperative sources.

The study also finds prominent changes in global knowledge production, as many countries in the Global South are still under signified because they lack adequate funding, research infrastructure or specialized training, as well as having limited chances to collaborate with other countries. Such imbalances can limit the scope of existing evidence and its application across the world.

More efforts are needed to build up international organizations, especially South–South partnerships, capacity-building programs, funding for research and engaging in multilingual and culturally relevant research, for a more impartial and inclusive research for ASD. Better variety in contribution will extend the evidence base, contribute a diversity of viewpoints and make the findings from research more relevant in several cultural and healthcare settings. As a whole, the field is rolling rapidly; however, a comprehensive, more connected research environment is a priority for future development.

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