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Evolution and emerging directions in occupational therapy for autism: A bibliometric evaluation of global literature

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Abstract

The study aims to explore global research trends, influential themes, and existing gaps in occupational therapy (OT) related to Autism Spectrum Disorder (ASD). It seeks to provide clinicians and researchers with comprehensive insights into the evolution, focus areas, and impact of OT interventions in managing ASD. A bibliometric analysis was conducted using data extracted from the Scopus database. A total of 1,002 peer-reviewed journal articles published between 1989 and 2024 were retrieved based on a targeted search strategy incorporating keywords relevant to OT and ASD. Bibliometric tools were utilized to analyze publication trends, influential authors and journals, collaboration networks, citation patterns, and keyword co-occurrences. The analysis revealed a significant rise in publications over the past decade, with the United States leading in both output and citations. Key themes include sensory-based interventions, daily living skills, and an emerging interest in telehealth and virtual reality. Notably, research is predominantly focused on children, with limited studies on adults, culturally diverse populations, and specific OT interventions like vocational training. Visual mapping indicated evolving research priorities and interdisciplinary collaboration patterns. Occupational therapy plays a critical role in ASD intervention. However, despite the increasing research volume, notable gaps persist particularly in long-term outcome studies, adult populations, cultural inclusivity, and technology-driven interventions. Addressing these gaps will enhance the efficacy and reach of OT strategies in ASD care. This study offers evidence-based direction for future OT research and clinical application in ASD. It encourages stakeholders to prioritize longitudinal designs, diversify study populations, and integrate innovative technologies into therapeutic frameworks to improve functional outcomes and quality of life for individuals with ASD.

Keywords: Autism spectrum disorder, Bibliometric analysis, Occupational therapy, Research trends, Sensory integration, Telehealth.

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1. Introduction

Occupational therapy has made substantial progress in recent years, especially in its approaches and interventions for individuals with Autism Spectrum Disorder (ASD) [1]. ASD is a complex neurodevelopmental condition characterized by challenges in social interaction, communication, and repetitive behaviors [2]. The increasing prevalence of ASD has underscored the necessity for effective therapeutic interventions, with occupational therapy emerging as a key approach [3].

Occupational therapy focuses on enhancing an individual's ability to perform daily activities and promoting independence [4] and enhancing social participation [5], which is especially important for individuals with ASD who often struggle with basic life skills.

Over the years, occupational therapists have developed and implemented various interventions, such as sensory integration therapy [6], play therapy [7], and activities of daily living (ADL) training [8] to address the unique needs of individuals with ASD. While these intervention strategies are vital, the primary focus of this study is on analyzing the broader landscape of occupational therapy research related to ASD. Specifically, there remains a need to systematically examine the breadth and impact of the research in this field to identify trends, the most active publication sources and the locations of active research in this field, gaps, and areas for future exploration, which could guide the development of more effective therapeutic strategies.

A bibliometric analysis offers valuable insights into the research landscape by systematically examining the volume, impact, and distribution of scientific publications [9, 10]. Bibliometric analysis is a systematic method used to assess the volume, impact, and patterns of academic literature within a specific field [9]. This type of analysis involves the quantitative evaluation of publications, citations, and collaboration networks, providing insights into the evolution of research topics, influential studies, and emerging trends in selected topics [11, 12]. In the context of occupational therapy for ASD, bibliometric analysis allows us to map the development of the field, identify key themes and gaps, and understand the global distribution of research efforts. By analyzing a large dataset of published articles, we can assess how the focus of research has shifted over time and highlight areas that require further exploration. Our study utilizes bibliometric tools such as VOSviewer [13, 14] and Biblioshiny [13, 15] to visualize co-authorship networks, keyword co-occurrences, and citation patterns, providing a comprehensive overview of the research landscape in this field.

Through this analysis, we aim to provide targeted insights into the evolution of occupational therapy research for ASD, with a specific focus on identifying the trends, influences, and gaps that directly impact the development and effectiveness of therapeutic interventions. By understanding these factors, we seek to guide future research and collaborative efforts that enhance the efficacy of occupational therapy practices for individuals with ASD. Such an understanding is critical for clinicians and researchers to make informed decisions about the direction of future research and practice.

2. Methods

2.1. Research Question, Data Collection and Screening Process

The purpose of the study is to explore the evolution of occupational therapy research in ASD, focusing on identifying trends, influences, and gaps that impact the development and effectiveness of therapeutic interventions. To achieve this, we formulated specific research questions that guided our analysis: 1) What are the primary themes and trends in occupational therapy research for ASD over the years? 2) How have different interventions in occupational therapy for ASD been studied and evolved? 3) What are the most active journals, countries, and the most cited works in this field? 4) What gaps exist in the current literature that need to be addressed to improve therapeutic outcomes for individuals with ASD?

The identification and collection of data for this bibliometric analysis were conducted in a structured manner to ensure the relevance and comprehensiveness of the dataset. The first step involved identifying pertinent keywords related to occupational therapy for ASD. For data collection, we selected the Scopus database due to its extensive coverage and reliability in indexing peer-reviewed literature [16]. Using the specified search word combinations, we conducted a search in the Scopus database targeting the 'Title,' 'Abstract,' and 'Keywords' fields of the articles. The keywords selected included "occupational therapy," "OT," "occupational intervention," "sensory integration therapy," "daily living skills," and "play therapy," in combination with "Autism Spectrum Disorder" or "Autism." The search string used in the Scopus database was as follows: (TITLE-ABS-KEY(("Occupational therapy" AND "Autism Spectrum Disorder") OR ("OT" AND "ASD") OR ("Occupational intervention" AND "Autism") OR ("Sensory integration therapy" AND "Autism") OR ("Daily living skills" AND "Autism Spectrum Disorder") OR ("Occupational therapy" AND "children with autism") OR ("Play therapy" AND "Autism Spectrum Disorder")). These keywords were chosen to capture a broad yet focused range of studies relevant to our research questions, ensuring that our analysis would cover the key aspects of occupational therapy research related to ASD.

The initial search yielded a total of 1,304 articles. To refine the results, we applied filters to include only articles published in journals and written in English, reducing the dataset to 1,003 articles. Subsequently, we downloaded the relevant files for further screening. During the screening process, we examined the dataset to identify and eliminate entries with missing information or duplicates. Only one duplicate was found and removed, resulting in a final dataset of 1,002 articles. The detailed process of data searching and screening is provided in Figure 1.

2.2. Inclusion and Exclusion Criteria

The inclusion criteria for this study were as follows: (1) Only articles published in English were considered. (2) Articles must be peer-reviewed journal publications; editorial pieces, letters, and conference proceedings were excluded. (3) Articles must include relevant keywords, specifically "occupational therapy," "OT," "occupational intervention," "sensory integration therapy," "daily living skills," or "play therapy," in combination with "Autism Spectrum Disorder" or "Autism." (4) The

articles must have a clear focus on the application of occupational therapy in ASD, specifically addressing therapeutic interventions such as sensory integration therapy, play therapy, daily living skills training, and outcomes related to social participation, communication, or adaptive behavior. (5) Only research studies exploring the efficacy, effectiveness, or implementation of occupational therapy strategies in ASD populations across various settings were included. (6) The date range for inclusion was set between 1989 and 2024 to capture the progression of research in this area.

Exclusion criteria were as follows: (1) Articles published in languages other than English were excluded. (2) Non-research publications, such as editorials, letters, and conference proceedings, were excluded to maintain the focus on empirical studies. (3) Articles that did not contain the specified keywords related to occupational therapy and ASD were excluded from the analysis. (4) Studies that mentioned occupational therapy, without a direct focus on its application to ASD, were excluded. (5) Duplicate articles were identified and removed from the dataset.

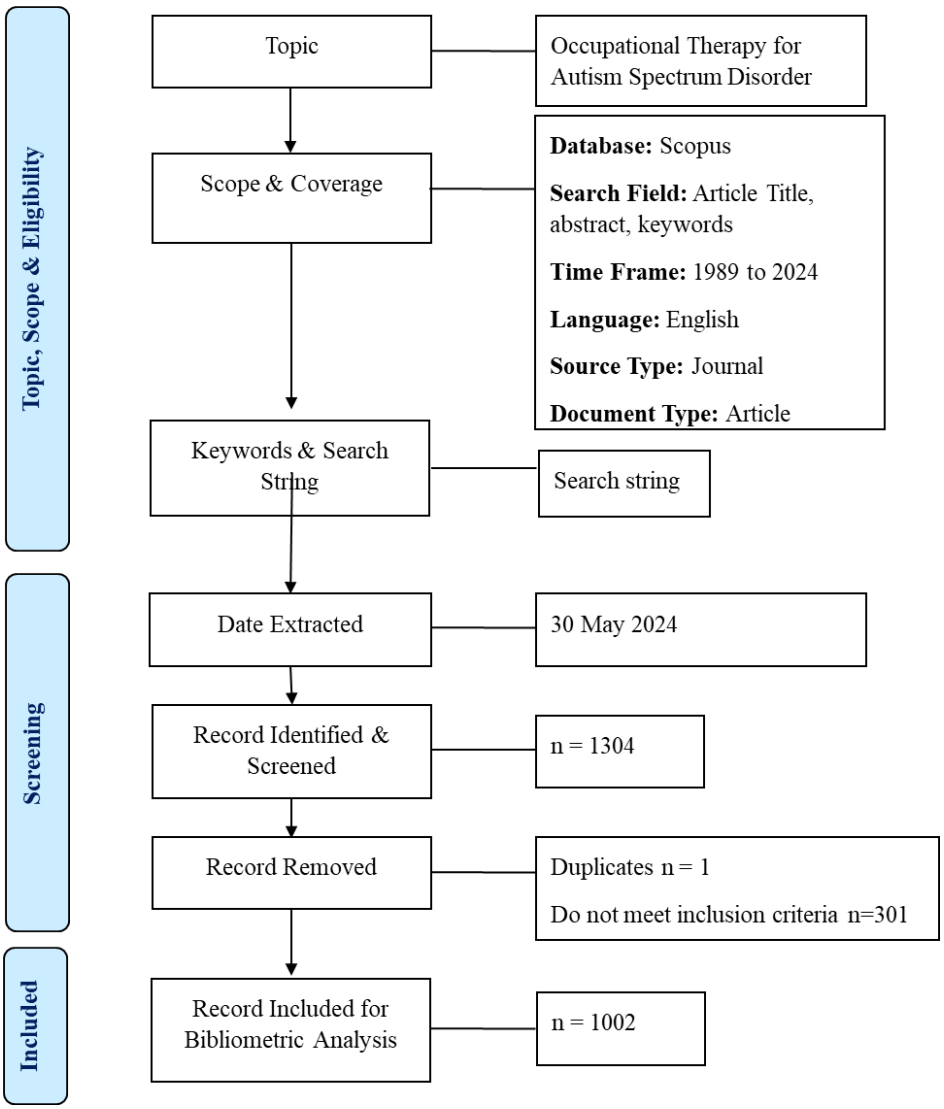

Figure 1.
Flow diagram of the search strategy.

2.4. The Bibliometric Method

The process of bibliometric analysis begins with data collection, where a well-defined search strategy is used to retrieve relevant literature based on specific keywords, titles, and abstracts. Once the data is gathered, a thorough cleaning process is conducted to remove duplicates, irrelevant entries, and incomplete records, ensuring the accuracy of the analysis. The cleaned data is then analyzed to determine key bibliometric indicators, such as the most cited articles, prolific authors, and influential journals, affiliations, or countries. Additionally, by examining citation patterns and trends, we can identify emerging topics and gaps in the literature that warrant further investigation. The results of a bibliometric analysis are presented in the form of visual maps and graphs, which not only illustrate the current state of research in a field but also highlight potential directions for future studies.

2.5. Data Analysis and Tools

For our bibliometric analysis, we employed a multi-software approach to ensure comprehensive data processing, visualization, and interpretation. The tools used included Microsoft Excel, VOSviewer, Biblioshiny, and CiteSpace, each

contributing unique functionalities to the analysis. Microsoft Excel was used for the initial collection and preprocessing of bibliometric data. This involved importing data from the Scopus database, cleaning the dataset to remove duplicates and irrelevant entries, and organizing the data into a structured format.

VOSviewer was employed for visualizing and analyzing bibliometric networks [13, 14]. This tool specializes in creating maps based on network data, enabling the visualization of co-authorship, co-citation, and keyword co-occurrence networks. VOSviewer provides graphical representations that offer insights into the relationships and clusters within the bibliometric data, highlighting influential authors, institutions, and research themes.

Biblioshiny, the web interface of the R package Bibliometrix, was used to conduct a descriptive analysis of the bibliometric data [15, 17]. This included generating detailed reports on publication trends over time, prolific authors, prominent journals, and key research topics. CiteSpace was utilized for keyword analysis within the bibliometric data [18]. CiteSpace's algorithms helped detect significant keywords and their evolution, providing insights into thematic progression and emerging areas of interest.

2.6. Data Examination and Visualization

We examined the final dataset of 1002 articles for various bibliometric indicators, including growth trajectory, influential authors and their locations, influential journals, top contributing countries, and institutions with high citation counts. The analysis also included keyword analysis to identify the main topics and trends within the field. The location analysis involved identifying the first author's country, the corresponding author's country, and the study site, with a global categorization for multi-country studies.

3. Results

3.1. Publication By Year

Figure 2 illustrates the publication trends of research papers on occupational therapy for ASD from 1989 to 2024. Initially, from 1989 to 2008, the number of publications remained consistently low, with fewer than 10 papers published each year. This period of minimal activity indicates a limited research focus on the intersection of occupational therapy and ASD. However, the early 2010s marked the beginning of a gradual increase in research output, reflecting growing interest and recognition of the importance of this field. By 2019-2020, there was a significant uptick in the number of papers, indicating a growing research community and increased scholarly attention to the topic.

The period between 2010 and 2020 saw a rapid escalation in the number of publications: 89 papers in 2019 and 83 papers in 2020. This sharp rise underscores a decade of intense research activity and possibly increased funding and awareness regarding the benefits of occupational therapy for individuals with ASD. A significant increase was observed in the last few years, with 119 and 107 papers in 2022 and 2023, respectively.

The historical overview of publication trends reveals a significant increase in research output over the past decade, this contributes to the study's aim of understanding the evolution of occupational therapy in ASD. This surge in publications reflects a growing awareness and urgency to address the needs of individuals with ASD through occupational therapy.

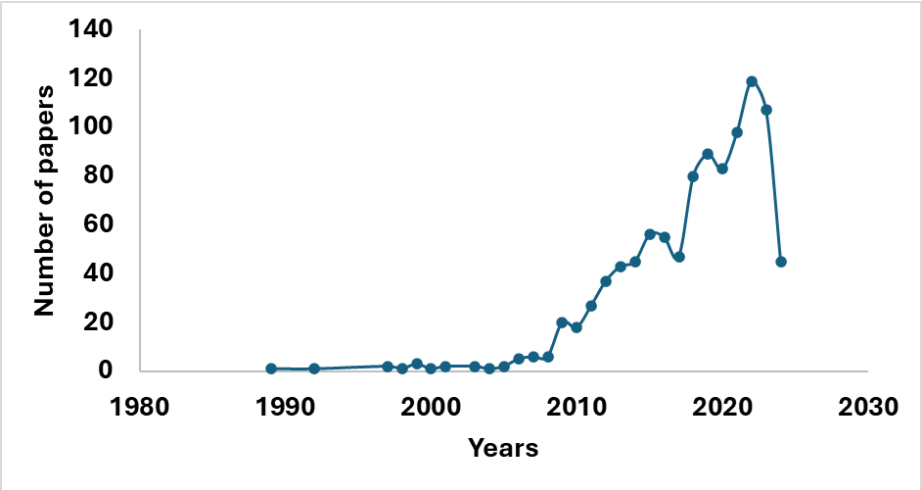

Figure 2.
The growth of publication on the Occupational Therapy for Autism Spectrum Disorder research.

3.2. Most influential Sources

Table 1 presents an overview of the top 20 journals contributing to the research on occupational therapy for ASD, ranked by the number of publications they have produced. The Journal of Autism and Developmental Disorders leads with 118 publications. The American Journal of Occupational Therapy and Autism follows, with 69 and 53 publications, respectively. These journals play critical roles in disseminating research that bridges occupational therapy and ASD. The American Journal of Occupational Therapy's focus on therapeutic techniques and interventions is particularly valuable for clinicians and therapists. Meanwhile, the journal Autism offers a broader perspective on ASD, including therapeutic approaches. Other

notable journals in the list include Research in Autism Spectrum Disorders, Australian Occupational Therapy Journal, and Journal of Occupational Therapy, Schools, and Early Intervention, with 40, 28, and 26 publications, respectively.

Table 1.
The Most Influential Journals Contributing to Occupational Therapy for Autism Spectrum Disorder Research.

Rank	Source Title	Number of Publications
1	Journal of Autism and Developmental Disorders	118
2	American Journal of Occupational Therapy	69
3	Autism	53
4	Research in Autism Spectrum Disorders	40
5	Australian Occupational Therapy Journal	28
6	Journal of Occupational Therapy, Schools, and Early Intervention	26
7	Autism Research	24
8	OTJR Occupation, Participation and Health	19
9	Focus on Autism and Other Developmental Disabilities	18
10	Occupational Therapy International	16
11	Frontiers in Psychiatry	11
12	Journal of Developmental and Behavioral Pediatrics	11
13	Research in Developmental Disabilities	11
14	Canadian Journal of Occupational Therapy	9
15	Pediatrics	8
16	Journal of the American Academy of Child and Adolescent Psychiatry	8
17	Journal of Neurodevelopmental Disorders	7
18	Scandinavian Journal of Occupational Therapy	7
19	International Journal of Developmental Disabilities	7
20	International Journal of Play Therapy	7

3.3. Geographical Data and Global Collaboration in Articles

In this analysis, we identified the leading countries based on the number of publications and citations. Identifying the leading countries in occupational therapy research for ASD helps to highlight where the most significant advancements and contributions are being made.

Table 2 provides a summary of the top 20 countries in terms of research publications and citation counts. The United States ranks highest with the most publications (560) and also leads in citations (18,025). Canada holds the second position in citations with 1,876, while Australia ranks second in terms of article publications with 80. The United Kingdom is third in both publications (55 articles) and citations (1,388).

VOSviewer was used to visualize the co-authorship analysis, with countries as the unit of analysis. The criteria were set to a minimum of 10 publications by a country with at least 5 citations. We found that only 21 out of 72 countries met these criteria. Figure 3 shows that the most significant collaborations were between the United States, Australia, and the United Kingdom. Additionally, for a more detailed network analysis between co-authors, we used Biblioshiny. This analysis evaluated collaborations in terms of single-country collaborations and multiple-country collaborations. The results indicate that authors from the United States have collaborated both locally and internationally. The details of these collaborations are illustrated in Figure 4.

The table lists the top 20 countries contributing to research on occupational therapy for Autism Spectrum Disorder, ranked by the number of citations their publications have received.

Table 2.
Top Contributing Countries in Occupational Therapy Research for Autism Spectrum Disorder.

Rank	Country	Citations	Documents
1	United States	18025	560
2	Canada	1876	50
3	United Kingdom	1388	55
4	Australia	1299	80
5	Israel	837	21
6	Germany	735	17
7	Japan	703	26
8	Italy	596	23
9	Netherlands	516	13
10	Sweden	488	20
11	China	297	18
12	Switzerland	296	10
13	India	278	33
14	France	277	16
15	Taiwan	263	14
16	Spain	231	23
17	Greece	216	8
18	Belgium	210	8
19	Egypt	203	6
20	South Korea	202	9

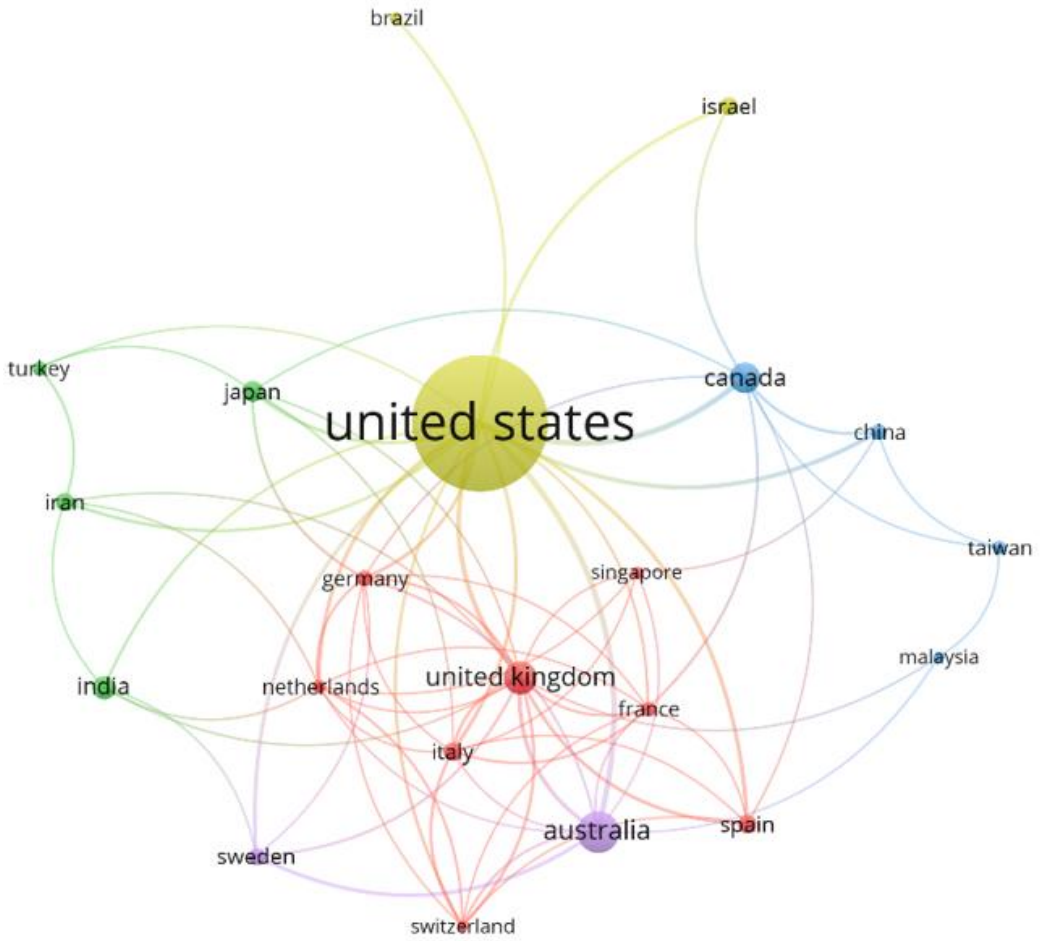

Figure 3.
A network visualization map generated by VOSviewer, illustrating the top contributing countries in the research field of occupational therapy for autism spectrum disorder.

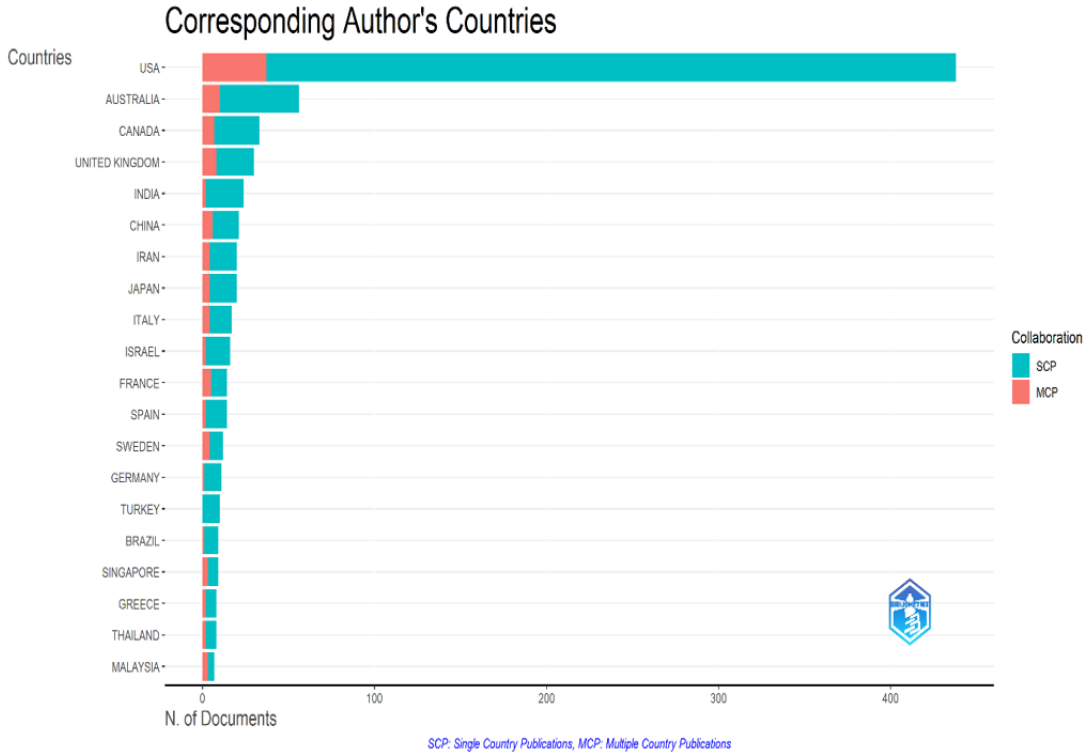

Figure 4.
Top 20 countries with highest number of publications based on Corresponding Authors. SCP=single country publication, MCP=Multiple country publication.

3.4. Three-Field Plot

The Sankey diagram presented in Figure 5 presents a detailed visualization of the collaboration patterns among top universities, countries, and the most prevalent research domains. The leftmost column (AU_UN) lists leading universities, the middle column (AU_CO) shows their corresponding countries and the rightmost column (DE) highlights the dominant research topics. In terms of institutional contributions, the University of California, Vanderbilt University, and Harvard Medical School are among the most prominent institutions contributing to research, with strong links to various countries, notably the USA. These institutions have multiple connections to various countries, indicating their extensive involvement in international research collaborations.

In the Geographical Distribution, the USA emerges as the leading country in research output, followed by Japan, Hungary, the United Kingdom, and Australia. This indicates a significant concentration of research activities in these nations, with other countries like Canada, Spain, Germany, and India also making notable contributions.

The dominant research topics include "autism spectrum disorder," "autism," "occupational therapy," "autism spectrum disorders," and "daily living skills." These topics reflect the primary focus areas of the institutions and countries involved.

In the rightmost column, DE offers insights into the primary focus areas of the studies conducted. The most frequently occurring terms, such as "autism spectrum disorder," "autism," and "occupational therapy," highlight the central themes of the research. Keywords like "oxytocin," "daily living skills," and "adaptive behavior" point to specialized areas of interest and specific therapeutic approaches being explored. The presence of terms related to demographic groups, such as "children," "adolescents," and "parents," indicates a comprehensive approach that considers the needs of different age groups and family dynamics in ASD therapy.

There is a dense network of connections between institutions in the USA and various research topics, indicating a robust research effort. Japanese universities also show strong ties to multiple research areas, particularly related to autism spectrum disorders and interventions. Universities like Kanazawa University and Hamamatsu University School of Medicine in Japan are linked to specific research areas such as oxytocin and intellectual disability, highlighting regional research strengths. Similarly, institutions from the United Kingdom, such as Cardiff University and King's College London, are prominently connected to studies on adaptive behavior and intervention.

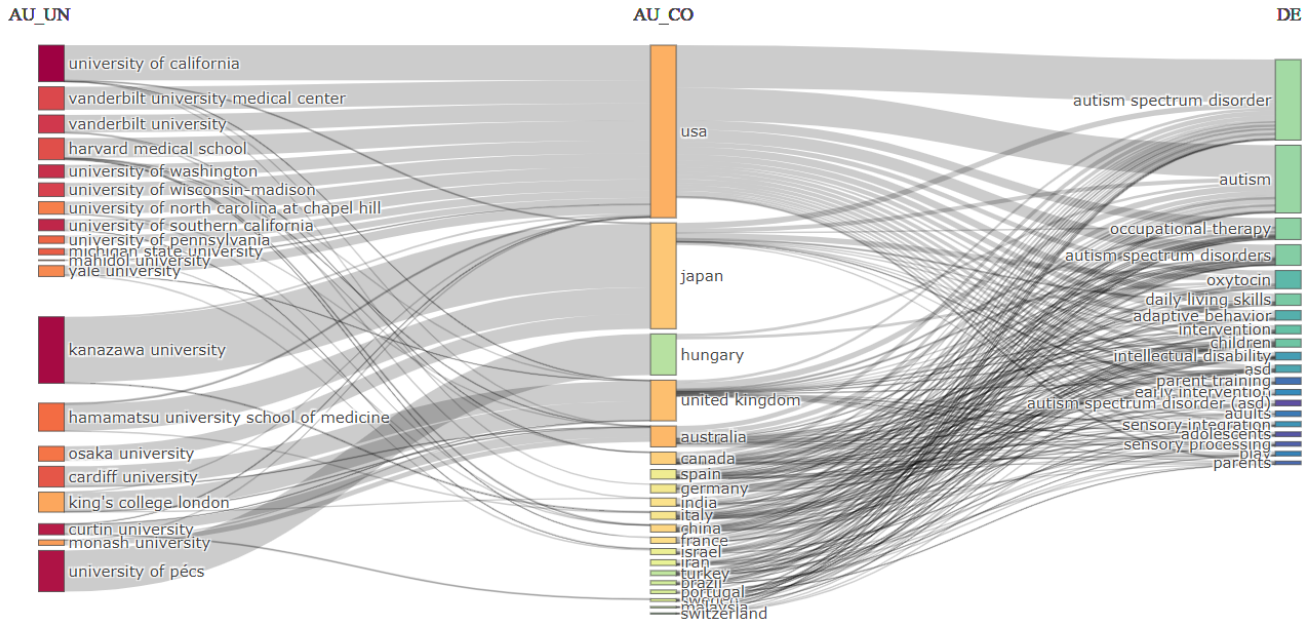

Figure 5.
Sankey Diagram of University Collaborations, Countries, and Research Keywords in Occupational Therapy for Autism Spectrum Disorder Research.

3.5. Most Cited Articles

The most cited article was "Early behavioral intervention, brain plasticity, and the prevention of autism spectrum disorder" by Dawson [19]. This article was cited 734 times, with the average citation per year being 45.88. The second most cited article was "Parenting stress and psychological functioning among mothers of preschool children with autism and developmental delay" by Estes et al. [20] with a total of 534 citations and the average citation per year was 35.6, published in the journal *"Autism"*. The third top-cited article in the field of autism and occupational therapy was "Effects of a brief early start Denver model (ESDM)-based parent intervention on toddlers at risk for autism spectrum disorders: A randomized controlled trial" by Rogers et al. [21] with 421 citations and with the average of 35.08 citations per year, published in *"Journal of the American Academy of Child & Adolescent Psychiatry"*. The top-cited articles are summarized in Table 3.

Table 3.
Top-cited research articles in the research field of occupational therapy for autism spectrum disorder.

Title	Authors	Cites	Year	Cites/Year
Early behavioral intervention, brain plasticity, and the prevention of autism spectrum disorder	Dawson [19]	734	2008	45.88
Parenting stress and psychological functioning among mothers of preschool children with autism and developmental delay	Estes, et al. [20]	534	2009	35.6
Effects of a brief early start Denver model (ESDM)-based parent intervention on toddlers at risk for autism spectrum disorders: A randomized controlled trial	Rogers, et al. [21]	421	2012	35.08
Prevalence of motor impairment in autism spectrum disorders	Ming et al. [22]	409	2007	24.06
Parental report of health conditions and health care use among children with and without autism: National survey of children's health	Gurney, et al. [23]	328	2006	18.22
A comparison of the performance of children with and without autism on the sensory profile	Kientz and Dunn [24]	317	1997	11.74
Association between the oxytocin receptor (OXTR) gene and autism: relationship to Vineland adaptive behavior scales and cognition	Lerer, et al. [25]	288	2008	18
Parenting-related stress and psychological distress in mothers of toddlers with autism spectrum disorders	Estes, et al. [20]	285	2013	25.91
The effect of therapeutic horseback riding on social functioning in children with autism	Bass, et al. [26]	274	2009	18.27
Sensory-motor and daily living skills of preschool children with autism spectrum disorders	Jasmin, et al. [27]	245	2009	16.33
Brief report: The Vineland Adaptive Behavior Scales in young children with autism spectrum disorders at different cognitive levels	Perry, et al. [28]	231	2009	15.4

Predicting Spoken Language Level in Children with Autism Spectrum Disorders	Yoder and Stone [29]	222	2001	9.65
The Sensory Profile: A discriminant analysis of children with and without disabilities	Ermer and Dunn [30]	194	1998	7.46
Comparison of Sensory Profile scores of young children with and without autism spectrum disorders	Watling, et al. [31]	191	2001	8.3
Effectiveness of sensory integration interventions in children with autism spectrum disorders: A pilot study	Pfeiffer, et al. [32]	190	2011	14.62

3.6. Most Published Articles by an Author

In this analysis, we have identified the top 20 authors with the highest number of publications on the chosen topic. The top 3 most active authors in this domain are Winnie Dunn from the University of Missouri, Columbia, United States, with ten publications cited 952 times. The second most published article by an author is Sharon Cermak of the University of Southern California, United States of America, who published 10 articles in the domain of autism and occupational therapy. The third author with the greatest number of publications is Zoe Mailloux from Thomas Jefferson University, United States of America, who has published 9 articles and has been cited 288 times. A summary of the highest number of articles by an author is provided in Table 4.

Table 4.
Key Authors and Their Contributions in Occupational Therapy for Autism Spectrum Disorder.

Authors	Affiliation	Documents	Citations
Dunn, Winnie	University of Missouri, Columbia, United States	10	952
Cermak, Sharon A.	University of Southern California, Los Angeles, CA, United States	10	434
Mailloux, Zoe	Thomas Jefferson University, Philadelphia, PA, United States	9	288
Cordier, Reinie	Curtin University, Perth, WA, Australia	8	75
Mandell, David S.	University of Pennsylvania, United States	8	268
Schaaf, Roseann C.	Thomas Jefferson University, Philadelphia, PA, United States	8	255
Lord, Catherine	University of California, Los Angeles, CA, United States	7	782
Polido, José C.	University of Southern California, Los Angeles, 90089, CA, United States;	7	355
Dawson, Geraldine	University of Southern California, Los Angeles, United States	6	2067
Duncan, Amie	University of Cincinnati College of Medicine, Cincinnati, OH, United States	6	87
Kasari, Connie	University of California, Los Angeles, CA, United States	6	262
Lin, Ling-Yi	National Cheng Kung University, Tainan, Taiwan	6	138
Watling, Renee	University of Puget Sound, Tacoma, WA, United States	6	166
Wilkes-Gillan, Sarah	Australian Catholic University, Sydney, NSW, Australia	6	45
Alaerts, Kaat	University of Leuven, KU Leuven, Belgium	5	130
Huri, Meral	Hacettepe University, Ankara, Turkey	5	62
Jacob, Suma	University of Minnesota, Minneapolis, MN, United States	5	146
Joosten, Annette	Curtin University, Perth, Western Australia, Australia	5	31
Kenworthy, Lauren	George Washington University, Washington, D.C., United States	5	364
Reynolds, Stacey	Virginia Commonwealth University, Richmond, VA, United States	5	328

3.7. Top Institutes with the Highest Number of Citations

Cornell University leads in the research of occupational therapy for ASD with 720 citations and an average citation score of 240. The University of Washington follows with 428 citations and an average citation score of 142.6667. Emory University School of Medicine, although with fewer total citations (110), maintains a strong average citation score of 36.6667. Other notable contributors include the University of California, the University of Puget Sound, Rush University, the University of Missouri, Vanderbilt University, and the University of Delaware, each demonstrating varying degrees of research impact through their respective average citation scores (Table 5).

Table 5.
Key Institutes and Their Research Impact on Occupational Therapy for Autism Spectrum Disorder.

Institutes	Citations	Avg. Citation Score
Cornell University, United States	720	240
University of Washington, United States	428	142.6667
Emory University School of Medicine, United States	110	36.6667
University of California, United States	93	23.25
University of Puget Sound, United States	91	30.3333
Rush University, United States	87	29
University of Missouri, United States	85	28.3333
Vanderbilt University, Nashville, Tn, United States	78	26
University of Delaware, United States	76	15.2

3.8. Keywords Analysis

The tabulated data presented in Table 6 highlights the top keywords utilized by authors and offers a brief representation of the dominant subjects in autism research. The term "Autism Spectrum Disorder" is the most commonly used keyword, appearing 292 times. It is closely followed by the term "Autism," which appears 248 times. The frequency of the terms "Occupational Therapy" (97 occurrences) and "Daily Living Skills" (45 occurrences) is noted. The frequent use of "Autism Spectrum Disorders" (88 instances) indicates minor differences in terminology. A significant focus on specific demographics is evident with keywords like "Children" (40 occurrences), "Adolescents" (16 occurrences), and "Adults" (19 occurrences). The keyword "Intervention" (36 occurrences) and its subset "Early Intervention" (22 occurrences) highlight various strategies being researched. Additionally, "Intellectual Disability" (30 occurrences) and "Adaptive Behavior" (30 occurrences) indicate a notable overlap in research areas. Keywords such as "Oxytocin" (35 occurrences), "Sensory Processing" (17 occurrences), "Play" (21 occurrences), and "Sensory Integration" (23 occurrences) reflect an interest in the biological and sensory dimensions of autism. The roles of families and caregivers are represented by "Parents" (17 occurrences) and "Parent Training" (17 occurrences).

Table 6.
Top Authors' Keywords in Research on Occupational Therapy for Autism Spectrum Disorder.

Label	Co-Occurrences
Autism Spectrum Disorder	292
Autism	248
Occupational Therapy	97
Daily Living Skills	45
Autism Spectrum Disorders	88
Children	40
Intervention	36
Intellectual Disability	30
Adaptive Behavior	30
Oxytocin	35
Sensory Processing	17
Play	21
Asd	30
Adolescents	16
Parents	17
Adults	19
Sensory Integration	23
Parent Training	17
Adolescence	9
Early Intervention	22

The density visualization of author keywords in autism research highlights several key themes (Figure 6). "Autism," "Child," and "Autism Spectrum Disorder" are central keywords, reflecting their primary focus in the literature. Peripheral yet significant keywords include "Humans," "Female," "Male," and "Occupational Therapy," indicating studies on gender differences and therapeutic approaches. Keywords like "Adolescent," "Controlled Study," and "Major Clinical Study" emphasize clinical research and specific age groups. Clusters around "Preschool Child," "Behavior Therapy," "Speech Therapy," and "Play Therapy" suggest a focus on early interventions and various therapies. Additionally, terms such as "Daily Life Activity," "Intellectual Impairment," and "Adaptive Behavior" highlight practical skills and cognitive aspects.

The keyword co-occurrence network visualization in Figure 7 reveals key themes in autism research. The minimum number of co-occurrences was set to 10. Central keywords such as "Autism Spectrum Disorder," "Autism," and "Occupational Therapy" dominate the literature.

Major research themes include intervention and therapy, with frequent mentions of "Intervention," "Early Intervention," "Play Therapy," and "Sensory Integration Therapy." Population-specific terms like "Children," "Adolescents," "Adults," and "Parents" indicate focused studies on different demographic groups. The second theme involves skills and behavior, such as "Daily Living Skills," "Adaptive Behavior," and "Social Skills," which are prominent.

Health and treatment aspects are underscored by terms like "Diagnosis," "Treatment," "Systematic Review," "Oxytocin," and "Anxiety." The use of technology in treatment is indicated by "Telehealth," "Virtual Reality," and the contextual impact of "COVID-19." Keywords like "Rehabilitation" and "Vocational Rehabilitation" highlight support for daily and professional life. Additionally, social and cognitive aspects, represented by "Social Communication," "Social Cognition," and "Executive Function," along with environmental factors like "Participation" and "Activities of Daily Living," underscore the multifaceted approach in autism research.

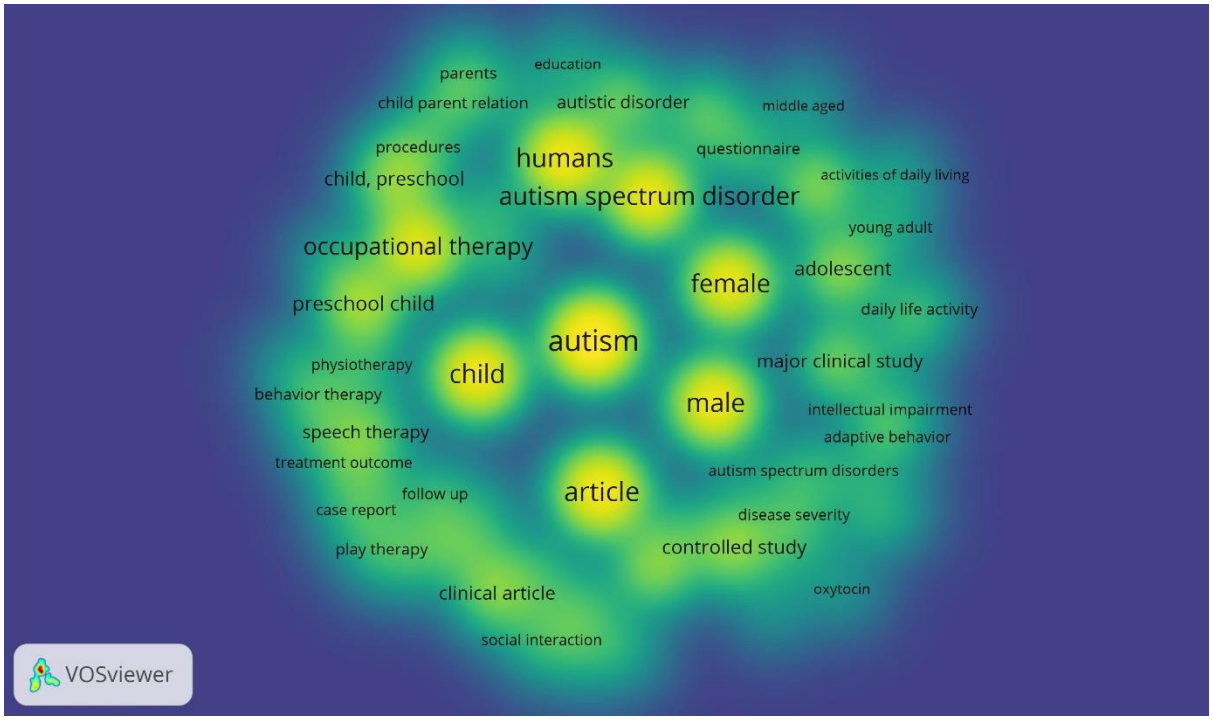

Figure 6.
Density of Author's Keywords Co-occurrence in Research on Occupational Therapy for Autism Spectrum Disorder.

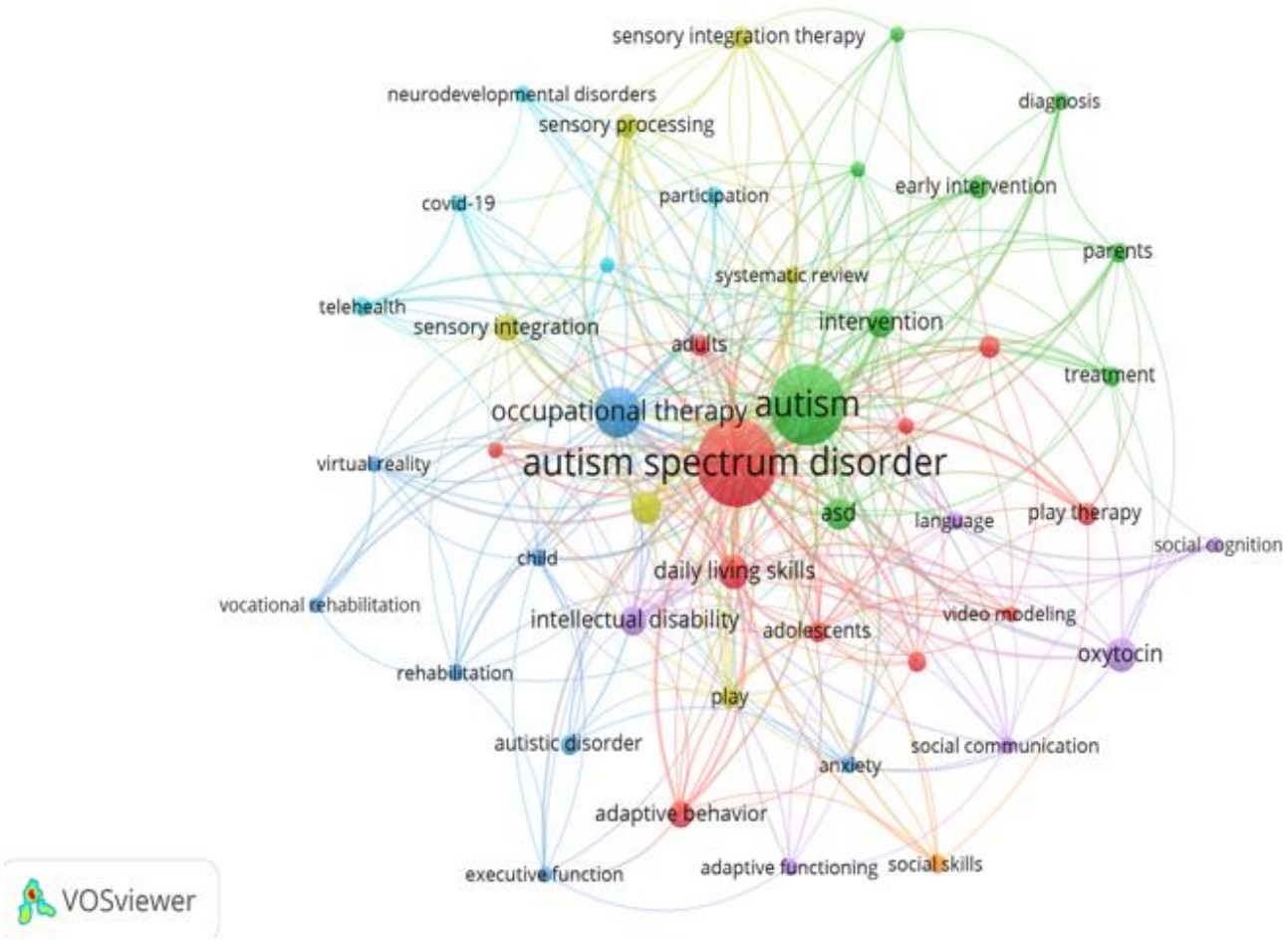

Figure 7.
The Co-occurrence of Keywords in Research Related to Occupational Therapy for Autism Spectrum Disorder.

3.9. Word Cloud

Figure 8 displays the most frequently occurring keywords in occupational therapy research related to ASD. The size of each word represents the frequency of its occurrence in the dataset, with larger words indicating higher frequencies. Key terms include "autism," "autism spectrum disorder," "occupational therapy," "human," "child," "male," "female," "adolescent," and "article.".

The inclusion of terms like "clinical article," "controlled study," and "major clinical study" suggests a strong emphasis on research and evidence-based clinical practices in this field. Keywords related to specific interventions and outcomes, such as "behavior therapy," "speech therapy," "play therapy," and "treatment outcome," reflect the diverse approaches and goals of occupational therapy for individuals with ASD.

Figure 8.
Word Cloud of Top Keywords in Occupational Therapy for Autism Spectrum Disorder Research.

3.10. Identified Gaps

Table 7 provides a summary of gaps identified after reviewing the articles and themes provided in this study. The identified gaps in the occupational therapy literature for ASD include a lack of longitudinal studies, limiting our understanding of long-term intervention effects. There is also a significant underrepresentation of culturally diverse populations, which restricts the generalizability of current findings. Additionally, research on adult populations and specific occupational therapy interventions, such as travel training and work-related skills, is scarce. Lastly, while technological interventions like telehealth are emerging, more solid evidence is needed to support their widespread adoption.

Table 7.
Identified Gaps in Occupational Therapy Literature for Autism Spectrum Disorder (ASD).

Identified Gap	Description	Source
Lack of Longitudinal Studies	Few studies have investigated the long-term effects of occupational therapy interventions for ASD.	Results from literature analysis
Limited Research on Culturally Diverse Populations	The majority of studies are conducted in Western contexts, limiting the generalizability of findings.	Results from literature analysis
Underrepresentation of Adult Populations	Most research focuses on children and adolescents, with minimal studies on adults with ASD.	Results from literature analysis
Insufficient Focus on Specific Occupational Therapy Interventions	Limited research on specific interventions like travel training, education, and work-related skills.	Reviewer's suggestion and analysis
Gaps in Technological Intervention Research	Emerging technological interventions like telehealth need more solid support and evaluation.	Results from literature analysis

4. Discussion

The findings of this bibliometric analysis provide a comprehensive overview of the research trends, influences, and gaps in occupational therapy for ASD. To address our question about the historical overview of publications, the results showed that the significant increase in publications over the past decade highlights a growing recognition of the importance of occupational therapy in enhancing the quality of life for individuals with ASD. This surge in research can be attributed to increased funding, heightened awareness, and a broader acceptance of occupational therapy as a vital intervention for ASD.

In addressing our research question on the leading contributors in the field, our bibliometric analysis confirms that the United States emerged as the leading contributor to research on occupational therapy for ASD, both in terms of the number of publications and citations. Other notable contributors include Canada, Australia, and the United Kingdom, reflecting a global interest in this field. The collaboration networks, particularly between the United States, Australia, and the United Kingdom, further emphasize the international effort to advance research and share knowledge. These countries were reported for their maximum contribution to various applications of occupational therapy [33].

In line with our research question on the evolution of interventions in occupational therapy for ASD, our findings indicate a significant shift towards technology-driven solutions. Keywords like "Autism Spectrum Disorder," "Autism," and "Occupational Therapy" are by default central to the research landscape. The focus on "Daily Living Skills" and "Sensory Integration" indicates a strong emphasis on practical and sensory-based interventions. The trend analysis showed evolving research interests, with recent years seeing a shift towards technological interventions such as telehealth and virtual reality, particularly in response to the COVID-19 pandemic. Several analytical articles from the past decades have emphasized the need for future research to build a stronger evidence base and develop occupation-based assessments, face-to-face activities, and interventions [3, 34]. Our study results align with these observations, confirming that there is a substantial body of research dedicated to these practical interventions. The trend analysis revealed a notable shift in recent years towards incorporating technological interventions, such as telehealth and virtual reality, particularly driven by the constraints and necessities imposed by the COVID-19 pandemic. These technological solutions have shown promise in delivering effective therapy remotely, ensuring continuity of care even when face-to-face interactions are limited.

Our findings indicate a strong emphasis on sensory-based interventions, which may be partly due to our inclusion of terms like 'sensory integration therapy' in the search strategy. However, we also recognize the presence of other intervention types, such as work-related skills training, social skills training, and leisure activities. Additionally, we observed a recent trend towards the use of technological solutions, such as telehealth and virtual reality, as methods to deliver various interventions.

The word cloud provides a visual representation of the most prominent themes and topics in occupational therapy research for ASD. The dominant presence of terms like "autism," "autism spectrum disorder," and "occupational therapy" underscores the central focus on ASD and its therapeutic interventions. The prominence of demographic terms such as "human," "child," "male," "female," and "adolescent" indicates a broad interest in studying different age groups and genders within the ASD population. This result is significant because a 2011 study highlighted a long-established gender disparity in ASD research, pointing out a scarcity of studies focusing on how gender relates to core ASD symptoms, including their domains, severity, and breadth [35]. The current manuscript's findings show an improvement in this area, as evidenced by the frequent inclusion of gender-related keywords in recent research. This suggests a growing recognition of the need to understand ASD across different demographic groups, thereby contributing to more personalized and effective therapeutic approaches. The shift towards more inclusive research themes indicates a positive trend toward addressing previously

overlooked aspects of ASD, potentially leading to better-targeted interventions and improved outcomes for all individuals affected by ASD.

The AU_CO showed that the USA is the most prominent hub of research activity. The extensive connections between US universities and various research themes reflect the country's leading role in driving ASD research. Other countries, such as Japan, Hungary, the United Kingdom, and Australia, also play vital roles. This distribution underscores the global interest in ASD research and the importance of international cooperation in addressing the complexities of the disorder [36]. The involvement of multiple countries in ASD research indicates a broad recognition of the need for diverse perspectives and methodologies to develop effective therapeutic strategies.

The primary strengths of this bibliometric analysis lie in its comprehensive data collection and the use of robust analytical tools. By using the extensive coverage of the Scopus database and employing precise keywords, the study ensures the inclusion of relevant and high-quality literature. Another significant strength is the global perspective and the detailed trend and network analysis conducted in this study. By highlighting geographical data and global collaboration patterns, the analysis underscores the international efforts and contributions in the field of occupational therapy for ASD. This global perspective is crucial for fostering international cooperation and understanding research dynamics across different regions.

In response to our research question concerning gaps in the current literature, our analysis identifies four critical areas needing further exploration, such as the need for more longitudinal studies, insufficient focus on specific occupational therapy interventions, culturally diverse populations, and gaps in technological intervention research. The emphasis on high-impact publications and influential authors ensures that the analysis highlights the most significant contributions, guiding researchers and practitioners toward the most valuable resources.

This bibliometric analysis, while insightful, has several limitations that should be acknowledged. The reliance on the Scopus database and the inclusion of only English-language articles may have excluded relevant studies from other databases and non-English publications, potentially limiting the global representation of the research landscape. The exclusion of non-peer-reviewed publications could overlook emerging trends. Methodological limitations of the bibliometric tools and the focus on quantitative metrics like publication and citation counts do not necessarily reflect the qualitative impact of the research. The focus on specific keywords might inadvertently exclude related research using different terminologies. While our search strategy was designed to be comprehensive, focusing on key terms related to occupational therapy and ASD, we acknowledge that the omission of specific terms such as 'travel training,' 'school,' 'education,' 'work,' and 'cognition' may have resulted in the exclusion of relevant studies. These areas represent significant components of occupational therapy interventions for individuals with ASD. Future research should consider incorporating these terms to ensure a more inclusive review of the literature.

Future research in occupational therapy for ASD should focus on addressing the identified gaps, such as the need for more longitudinal studies to understand the long-term impacts of interventions. Additionally, exploring culturally diverse populations will be important for developing universally applicable therapeutic approaches. Embracing technological advancements, such as telehealth and virtual reality, can also enhance intervention strategies and accessibility.

5. Conclusions

This bibliometric analysis highlights the significant growth in research on occupational therapy for ASD over the past decade, driven by increased recognition of its importance in enhancing the quality of life for individuals with ASD. The United States leads in both publications and citations, with notable contributions from Canada, Australia, and the United Kingdom, reflecting a robust global research effort. The study reveals a strong emphasis on practical and sensory-based interventions, with recent trends shifting towards technological solutions such as telehealth and virtual reality. However, gaps remain, particularly the need for longitudinal studies and culturally diverse populations. Addressing these gaps through continued international collaboration and embracing technological advancements will be crucial for developing more effective and universally applicable therapeutic strategies.

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