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A Comprehensive Bibliometric Analysis of Disability Research in Saudi Arabia: Trends, Gaps, and Future Directions

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ABSTRACT

This study employed bibliometric analysis using the Scopus database to evaluate Saudi disability research (SDR). From an initial dataset of 17,102 documents (0.54% of global output), the scope was refined to 13,246 data-driven publications for detailed examination. Trends, themes, and collaborations were analyzed using R packages and VOSviewer. Metrics such as citations, total link strength (TLS), and thematic mapping were used to identify key contributors, emerging topics, and international partnerships. Saudi authors demonstrated strong international collaboration, with 59.53% of publications involving co-authorships, particularly with the United States, Egypt, and India. Prolific contributors include Alkuraya, F.S. and leading institutions such as King Saud University. Key motor themes include "quality of life" and "Alzheimer's disease," while emerging themes such as "deep learning" and "molecular docking" reflect a shift toward advanced technologies. Machine learning is a trending topic applied in early diagnosis, drug discovery, and rehabilitation of conditions such as Alzheimer's disease, autism, and epilepsy. These findings underscore the evolving priorities and global relevance of SDR.

KEYWORDS

Saudi disability research, bibliometric analysis, machine learning, international collaboration, thematic evolution

INTRODUCTION

The Saudi Arabian government envisions an inclusive life for its citizens, residents, and especially persons with disabilities [1]. A person with a disability has physical, sensory, mental, communicative, educational, or psychological barriers to fulfilling basic needs [2]. Disabilities can include, but are not limited to, blindness, hearing impairment, speech impairment, physical and motor disabilities, autism, and a wide range of learning disabilities. Therefore, everyone needs care in one form or another [3]. The Kingdom of Saudi Arabia (KSA) provides appropriate measures, including care, rehabilitation, and prevention, for all persons with disabilities, thereby enhancing the services offered to them [4]. Primary prevention through medical, psychological, social, educational, and other measures aims to construct a barrier against the onset and development of disabilities. Everyone is entitled to appropriate care services irrespective of their health, level of disability, or social standing [5]. According to KSA statistics, approximately 289,355-833,136 citizens have disabilities, constituting about 7.1% of the total population. The government aspires to achieve a fully productive society by recognizing the abilities of all individuals, rather than expecting everyone to perform the same tasks [6].

The King Salman Center for Disability Research facilitates the scientific study of individuals with disabilities by creating a comprehensive database based on scientific principles. This study also sought to develop solutions for the prevention and treatment of impairments [7]. The center employs optimal scientific methodologies and thoroughly documented datasets to develop scientific programs that seek to treat impairment, ascertain its origins, and facilitate early identification and intervention. Furthermore, research findings and outputs are utilized for planning and assessment across many domains of prevention, care, and rehabilitation, striving to mitigate the hardships of disability while enhancing the circumstances of persons with disabilities for productive employment [7, 8].

Disability research is critical for social integration, policymaking, and improving the quality of life of millions of people worldwide [9]. Examining the specifics of the situation and the difficulties faced by the disabled population helps in planning and implementing strategies that increase the level of care provided, accessibility, and equity [9, 10]. This overturns many conventional views, lowers the level of prejudice, and enhances comprehension of the population. In addition, research on disability encourages the advancement of assistive technology devices to ensure increased autonomy and participation of the disabled. It tackles workplace integration, healthcare inequalities, and multiple discrimination issues, which in turn supports disabled people and their families. Finally, research on disabilities assists in the transformation of society with disabilities into a more integrated, equal, and fair society [10, 11].

Disability research in the KSA remains underexplored [12], with no prior bibliometric studies analyzing its scope and trends. Addressing this gap is crucial for understanding the evolution, key themes, and collaborative networks of disability-related research and for informing evidence-based policies and strategies [13]. This study aimed to map researcher contributions, identify influential publications, and highlight areas needing greater focus to support inclusive practices and policies for people with disabilities. This analysis helps assess current efforts, recognize knowledge gaps, and prioritize future research by providing data-driven insights into local research strengths, emerging themes, and opportunities for international collaboration. The primary objective was to provide a comprehensive overview of disability research in the KSA, offering actionable insights to enhance research quality, visibility, and societal impact.

MATERIALS AND METHODS

Database selection

This study involved a sequence of inquiries in the Scopus database, which is exclusively dedicated to peer-reviewed publications. Scopus was chosen for its extensive multidisciplinary coverage, superior volume of articles available for indexing, and enhanced citation analysis capabilities compared to web of science and PubMed [14].

Data mining and search strategy

The search strategy followed a systematic approach, beginning with a comprehensive search of the Scopus database using a broad set of disability-related keywords (Supplementary File 1), yielding 3,183,950 global documents (Fig. 1). The dataset was refined by applying filters to focus on Saudi-affiliated English language research and excluding publications from 2025, resulting in 17,102 documents. A final refinement limited the scope to original articles (data-driven research), producing a dataset of 13,246 documents for detailed analysis. This approach ensured a targeted and relevant dataset for examining disability research trends and outputs in Saudi Arabia.

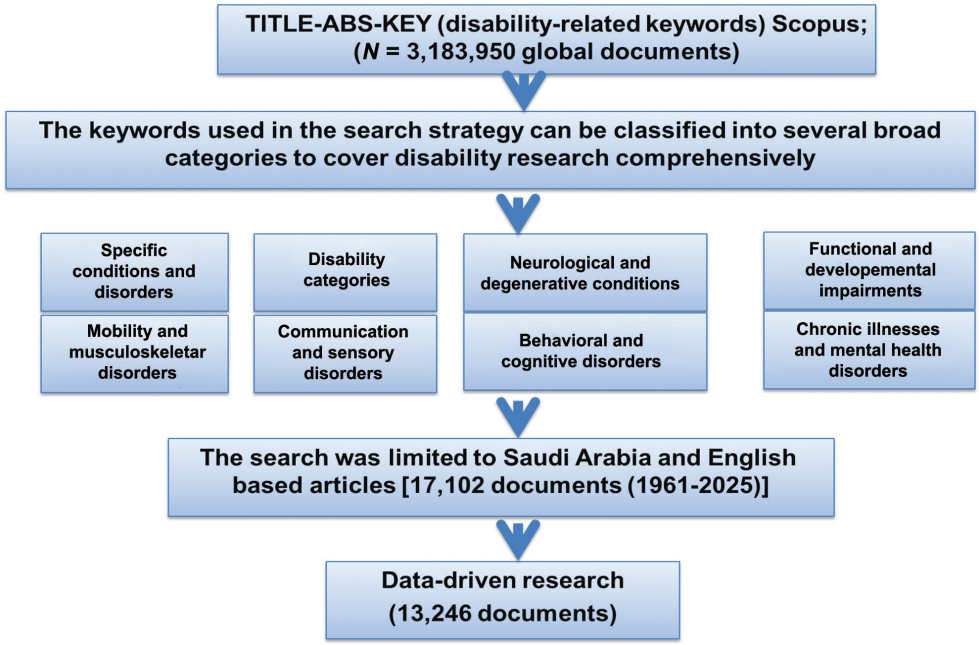

Figure 1: The flowchart illustrates the data collection and refinement process described in the sections "Database selection" and "Data mining and search strategy." It begins with an initial data search from the Scopus database using an extensive list of disability-related keywords without time restrictions. This search resulted in a preliminary dataset of 17,102 documents focused on Saudi-affiliated English language research, excluding publications from 2025. The dataset was further refined by filtering document types to include only data-driven research (original articles), resulting in a final dataset of 13,246 publications. The refined dataset was then exported in CSV and BibTex formats for bibliometric analysis. The flowchart provides a visual summary of this systematic process.

The keywords used in the search strategy can be classified into several broad categories to cover disability research comprehensively.

- **Specific conditions and disorders**: This category includes terms for specific disabilities and medical conditions, such as "Duchenne muscular dystrophy," "autism spectrum disorder (ASD)," "cerebral palsy," "sickle cell disease," and "Down syndrome." This ensured that the inclusion of the research focused on distinct conditions.
- **Disability categories**: Broad classifications such as "physical disabilities," "sensory disabilities," "cognitive disabilities," and "neurodevelopmental disabilities" offer a wide-ranging perspective on various forms of disabilities.
- **Functional and developmental impairments**: Keywords such as "mobility impairments," "communication disorders," "intellectual disabilities," and "developmental disabilities" address disabilities impacting specific functions or developmental aspects.
- **Chronic illnesses and mental health disorders**: Terms such as "fibromyalgia," "chronic pain conditions," "bipolar disorder," and "anxiety disorders" cover chronic illnesses and mental health-related disabilities.
- **Neurological and degenerative conditions**: Keywords such as "epilepsy," "Parkinson's disease," "multiple sclerosis," and "Alzheimer's disease" highlight the neurological and degenerative disorders relevant to disability research.
- **Behavioral and cognitive disorders**: This includes terms such as "ADHD," "conduct disorder," and "oppositional defiant disorder," capturing cognitive and behavioral disabilities.
- **Communication and sensory disorders**: Keywords such as "deafness," "hearing loss," "blindness," "aphasia," and "stuttering" cover sensory impairments and communication disorders.
- **Mobility and musculoskeletal disorders**: Terms like "spinal cord injuries," "arthritis affecting mobility," and "wheelchair use" reflect issues related to mobility and musculoskeletal challenges.

This classification ensures comprehensive coverage of disability research, addressing a wide spectrum of conditions; functional impairments; chronic illnesses; and neurological, behavioral, and sensory disorders. This captures the complexity and diversity of the field of disability studies.

Data analysis

Annual trends were analyzed using Microsoft Excel, while bibliometric statistics and visualizations were generated using VOSviewer [Centre for Science and Technology Studies (CWTS) at Leiden University in Leiden, Netherlands] [15] and the R package program (R Foundation for Statistical Computing in Vienna, Austria) [16], facilitating the extensive mapping of research focal points, geographical research areas, and topic clusters. The total link strength (TLS) in VOSviewer is a metric that quantifies the strength of relationships or connections between nodes (e.g., authors, institutions, and keywords) in a network map. It is used to assess the degree of collaboration, co-occurrence, or co-citation in bibliometric analyses [15]. The thematic map illustrates the principal concerns in the domain based on the author keywords. The purpose of creating a thematic map was to comprehend the current state and evaluate the future trajectory of research advancement on the topic. The map illustrates the intensity of their internal density, indicating inter-cluster development and outward connections, signifying the relevance of the study to a certain region of centrality. It is partitioned into four quadrants. The keyword thematic map categorizes the main research themes and topics within a specific field [16, 17]. The R package employed in this study, bibliometrix, is a widely used tool for bibliometric and scientometric analysis. It facilitates the visualization and interpretation of research trends, collaborations, and thematic structures. Its use was significant in generating insights, such as thematic evolution and co-authorship networks, contributing to a comprehensive understanding of the dataset [16]. Thematic mapping was conducted using bibliometrix. The map produced the Callon centrality and density. Callon centrality measures the degree of interaction between a research theme and other themes, indicating its importance in a broader research network. Callon density assesses the internal coherence of a theme, reflecting its development and maturity. These metrics were significant for categorizing research themes into motor, basic, niche, and emerging or declining categories, thereby identifying the thematic structure and evolution of Saudi disability research.

RESULTS

Saudi Arabia's contribution to global disability research

Saudi Arabia contributes approximately 0.54% of global disability research, with 17,166 publications out of a total of 3,183,950 disability-related publications. Table S1 shows the distribution of document types in Saudi disability research. Of these 17,166 documents, 13,246 were data driven, original English research articles, emphasizing the country's focus on advancing knowledge and solutions in the field.

Table 1 presents the ranking of the top authors and affiliations contributing to disability research publications in Saudi Arabia. Among the 17,166 publications, the top-ranking author was Kamal, M.A., and King Saud University led with 3968 publications. Alkuraya ranked second with 197 publications. Regarding data-driven publications, Alkuraya, ranked first with 178 publications, followed by Mokdad, A.H. with 111 publications. Key institutions include King Saud University, King Abdulaziz University, and King Faisal Specialist Hospital & Research Centre, indicating significant contributions from major Saudi academic and research centers. Cairo University (Egypt) is a non-Saudi institution that actively participates in disability research in Saudi Arabia, showcasing the value of cross-border academic collaboration.

Bibliometric analysis of data-based research

This section focuses on the bibliometric analysis of data-driven research, excluding other document types. Isolating

Table 1: Key contributors in all literature and data-driven studies.

	17,166 Publications				13,246 Data-driven publications			
Rank	Author	*N*	Affiliation	*N*	Author	*N*	Affiliation	*N*
1	Kamal, M.A.	214	King Saud University	3968	Alkuraya, F.S.	178	King Saud University	3245
2	Alkuraya, F.S.	197	King Abdulaziz University	2394	Mokdad, A.H.	111	King Abdulaziz University	1712
3	Ashraf, G.M.	183	King Faisal Specialist Hospital & Research Centre	1379	Ahmad, S.F.	108	King Faisal Specialist Hospital & Research Centre	1119
4	Mokdad, A.H.	119	Imam Abdulrahman Bin Faisal University	1185	Hay, S.I.	94	Imam Abdulrahman Bin Faisal University	911
5	Ahmad, S.F.	109	King Saud bin Abdulaziz University for Health Sciences	1089	Kamal, M.A.	94	King Saud bin Abdulaziz University for Health Sciences	884
6	Hay, S.I.	98	Prince Sattam bin Abdulaziz University	755	Nadeem, A.	92	King Khalid University	593
7	Yonemoto, N.	97	King Khalid University	743	Attia, S.M.	91	Prince Sattam bin Abdulaziz University	573
8	Fischer, F.	94	Umm Al-Qura University	725	Bakheet, S.A.	89	Princess Nourah Bint Abdulrahman University	546
9	Vos, T.	94	Princess Nourah Bint Abdulrahman University	647	Fischer, F.	89	Cairo University	543
10	Nadeem, A.	92	Cairo University	635	Yonemoto, N.	89	Umm Al-Qura University	533

empirical studies offers a clearer assessment of research trends, key contributors, and impactful work in Saudi disability research, thus providing valuable insights for advancing the field.

Growth of data-based research

This study's data reflect the growth and citation patterns of data-driven disability research from 1961 to 2024 (Fig. 2). During this period, 13,246 documents were produced with an annual growth rate of 12.69%, indicating substantial expansion in research activity over time. The average age of documents is 6.44 years, suggesting a relatively recent focus on impactful studies. On average, the articles received 28.23 citations, indicating significant engagement and influence within the research community. Figure 2 also shows the annual average number of citations per article, which fluctuates over time. Early years, such as 1975 and 1984, exhibited higher citation averages for a smaller number of documents, whereas recent years have seen an increase in document numbers, particularly in 2023 and 2024, with lower citation averages owing to their recency. The data illustrate historical trends and recent spikes in publications and their impact on disability research.

Most funding agencies

Table 2 presents the top funding agencies supporting disability research, ranked by the number of funded documents. King Saud University leads with 1986 documents, indicating its strong commitment to advancing research in this field. The National Institutes of Health (USA) and the U.S.

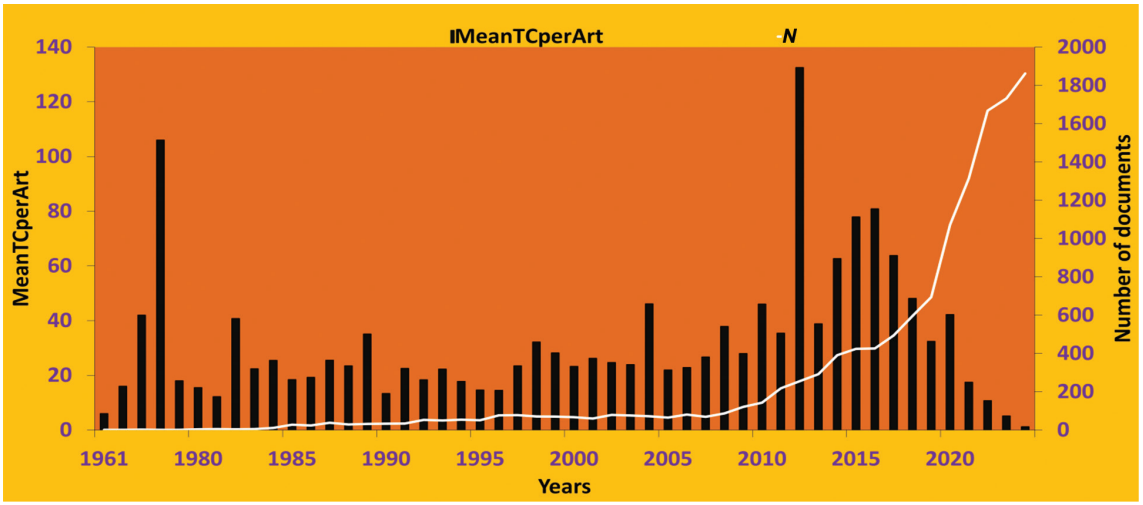

Figure 2: Mean total citation per article (MeanTCperArt) and number of documents per year (*N*). The white line indicates the number of articles. Bars represent the mean total citation per article.

Table 2: Top funding agencies contributing to disability research.

Rank	Funder	Number of documents
1	King Saud University	1986
2	National Institutes of Health, USA	531
3	U.S. Department of Health and Human Services	440
4	King Abdulaziz University	304
5	Princess Nourah Bint Abdulrahman University	275
6	King Abdulaziz City for Science and Technology	242
7	Prince Sattam bin Abdulaziz University	196
8	Indian Council of Medical Research	180
9	European Commission	169
10	King Salman Center for Disability Research	167
11	King Khalid University	158
12	UK Research and Innovation	157
13	Taif University	138
14	Deanship of Scientific Research, King Faisal University	134
15	National Institute on Aging	134

Department of Health and Human Services follow with 531 and 440 documents, respectively, demonstrating significant international support. King Abdulaziz University (304) and Princess Nourah Bint Abdulrahman University (275) have also contributed substantially. Other key Saudi institutions include King Abdulaziz City for Science and Technology (242), Prince Sattam bin Abdulaziz University (196), and King Salman Center for Disability Research (167). International agencies such as the Indian Council of Medical Research (180) and the European Commission (169) highlight global collaboration. King Khalid University, UK Research and Innovation, Taif University, the Deanship of Scientific Research (King Faisal University), and the National Institute on Aging also provided notable funding, showcasing a mix of local and international support for disability research.

Diffusion of knowledge

The distribution of disability research publications across various subject areas is presented in Table 3, highlighting the diffusion of knowledge within the field. Medicine dominated with 8606 publications (41.67%), followed by Biochemistry, Genetics, and Molecular Biology (2247, 10.88%) and Neuroscience (1466, 7.10%). Other significant fields include Pharmacology, Toxicology, and Pharmaceutics (1151, 5.57%), Computer Science (839, 4.06%), and Social Sciences (625, 3.03%). Contributions also spanned Engineering (623, 3.02%), Health Professions (586, 2.84%), Psychology (495, 2.40%), and Nursing (449, 2.17%). Lesser contributions came from fields such as Dentistry (158, 0.76%), Arts and Humanities (118, 0.57%), and Business, Management, and Accounting (46, 0.22%), indicating a broad yet varied distribution of research efforts across disciplines.

Table 3: Knowledge diffusion patterns within disability research.

Subject	*N*	%
Medicine	8606	41.67
Biochemistry, Genetics, and Molecular Biology	2247	10.88
Neuroscience	1466	7.10
Pharmacology, Toxicology, and Pharmaceutics	1151	5.57
Computer Science	839	4.06
Social Sciences	625	3.03
Engineering	623	3.02
Chemistry	595	2.88
Health Professions	586	2.84
Psychology	495	2.40
Nursing	449	2.17
Immunology and Microbiology	402	1.95
Multidisciplinary	387	1.87
Agricultural and Biological Sciences	335	1.62
Materials Science	321	1.55
Mathematics	283	1.37
Environmental Science	276	1.34
Chemical Engineering	273	1.32
Physics and Astronomy	223	1.08
Dentistry	158	0.76
Arts and Humanities	118	0.57
Business, Management, and Accounting	46	0.22
Veterinary	37	0.18
Energy	33	0.16
Earth and Planetary Sciences	29	0.14
Decision Sciences	26	0.13
Economics, Econometrics, and Finance	26	0.13

Core sources: Bradford's law

Bradford's Law of Scattering pertains to the principles of decreasing returns and dispersion. In 1948, Bradford articulated the law, asserting that within a specific topic area, there are a limited number of highly productive journals, a greater number of moderately productive journals, and an even larger number of journals exhibiting a continual decline in output. For any specific topic or subject area, the top third (zone 1 or core) comprises journals most frequently mentioned in the literature of that field, indicating their highest relevance to academics in the discipline. Bradford's law identified zone 1 sources accommodating Saudi research on disability, with a total of 3510 sources. The top 10 journals contributing to zone 1 are as follows: *Saudi Medical Journal* ranks first with 356 publications, followed by the *Annals of Saudi Medicine* with 201 publications and *Neurosciences* with 174 publications. *PLOS One* ranks fourth (125 publications), and *IEEE Access* has 99. Other journals include *Scientific Reports* (97), *International Journal of Environmental Research and Public Health* (96), *Saudi Pharmaceutical Journal* (94), *Healthcare (Switzerland)* (81), and *Molecules* (72). These sources represent the primary outlets for disability research in Saudi Arabia (Table 4).

Global landscape

The data highlight the global scope and impact of disability research, with Saudi Arabia producing 13,246

Table 4: Top most relevant sources for disability research publications.

Sources	Rank	Frequency	Cumulative frequency
Saudi Medical Journal	1	356	356
Annals of Saudi Medicine	2	201	557
Neurosciences	3	174	731
PLOS One	4	125	856
IEEE Access	5	99	955
Scientific Reports	6	97	1052
International Journal of Environmental Research and Public Health	7	96	1148
Saudi Pharmaceutical Journal	8	94	1242
Healthcare (Switzerland)	9	81	1323
Molecules	10	72	1395

publications. Notable collaborating countries include the United States (2150), Egypt (1992), India (1313), and the United Kingdom (1289) (Fig. 3a). Figure 3b shows that the United States leads with 135,086 citations, followed by Saudi Arabia with 67,106 citations, and significant contributions from the UK (15,652) and Canada (10,245). Saudi single-country publications (SCP) indicate a robust local research presence, with a multiple-country publication (MCP) ratio of 0.363, reflecting substantial international collaboration (Fig. 3c). Additionally, 59.53% of Saudi publications involve international co-authorships, with major collaborations occurring with the United States (2129 documents), Egypt (1977 documents), India (1308 documents), and other countries, demonstrating strong global research partnerships (Fig. 3d).

Mapping authors' impact and collaboration

The most cited and collaborative authors in Saudi disability research are highlighted in Table 5 and Figure 4. In terms of citations (Table 5), Alkuraya, led with 3538 citations, followed by Tuomilehto, J. (3450), Kivipelto, M. (3140),

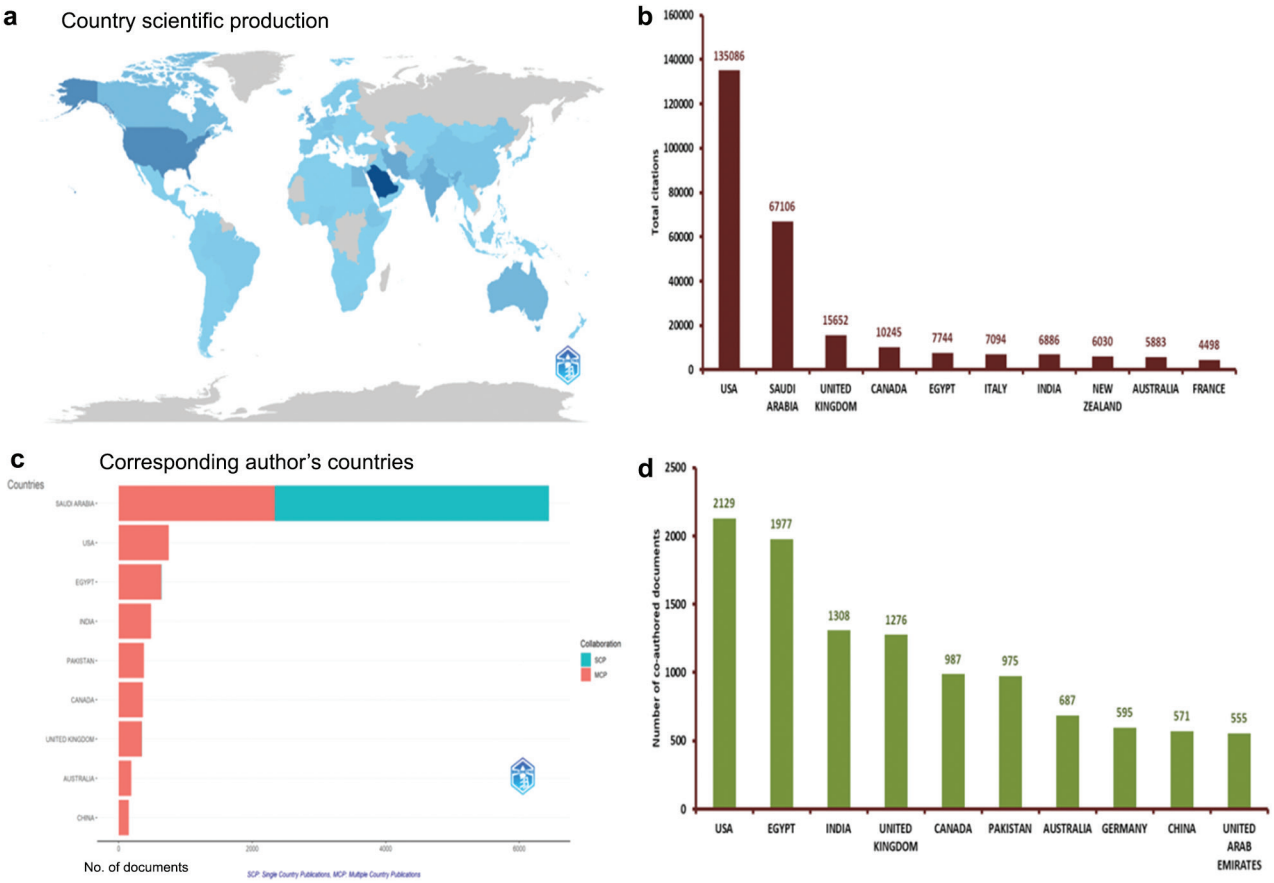

Figure 3: Saudi Arabia's global engagement in disability research. Figure 3a shows Saudi Arabia's total publications and its collaborations with key countries such as the United States, Egypt, India, and the UK. The most productive nations are represented in dark blue, while no contributions to this specific field have come from nations outside the blue group. The bibliometrix program and the BibTex data file were used to create this figure. Figure 3b highlights the most cited countries, led by the United States, with Saudi Arabia ranking second. Figure 3c presents the distribution of single-country publications (SCP) versus multiple-country publications (MCP), indicating a strong international collaboration ratio (0.363). Figure 3d details co-authorship patterns, showing that 59.53% of Saudi publications involve international partners, particularly with the United States, Egypt, and India.

Table 5: Most cited authors.

Rank	Author	Citations
1	Alkuraya, F.S.	3538
2	Tuomilehto, J.	3450
3	Kivipelto, M.	3140
4	Ngandu, T.	3140
5	Soininen, H.	3112
6	Nadeem, A.	1876
7	Kamal, M.A.	1865
8	Bakheet, S.A.	1846
9	Arabi, Y.M.	1809
10	Attia, S.M.	1806
11	Al-Ayadhi, L.Y.	1781
12	Bohlega, S.	1780
13	Ahmad, S.F.	1647
14	Salih, M.A.	1593
15	El-Ansary, A.	1527

Ngandu, T. (3140), and Soininen, H. (3112). Other notable authors include Nadeem, A. (1876), Kamal (1865), and Bakheet, S.A. (1846). These authors have significantly influenced the field through their impactful publications. Collaboration strength, measured using TLS *via* VOSviewer, identifies the most collaborative authors based on their co-authorship network. TLS serves as an index to evaluate the extent and strength of collaborative efforts. This analysis provides insights into key contributors based on citation impact and their roles in fostering research networks within and beyond Saudi Arabia. Figure 4 presents the most collaborative authors in Saudi disability research, measured by TLS. Ahmad, S. F. led with a TLS of 399, followed by Nadeem (395), Bakheet (389), and Attia, S.M. (388), highlighting their extensive research networks. Other notable collaborators include Ansari, M.A. (284), Al-Ayadhi, L.Y. (120), and Al-Mazroua, H.A. (119). These authors demonstrate strong co-authorship networks, contributing significantly to the collaborative landscape of Saudi disability research.

Terms' cloud

Figure 5 presents the word cloud of the top 50 most frequent author keywords in Saudi disability research. The list is led by "Saudi Arabia," with 832 occurrences, indicating a strong focus on region-specific studies. Other prevalent terms include "epilepsy" (363), "depression" (263), "anxiety" (258), "Alzheimer's disease" (253), "sickle cell disease" (248), and "COVID-19" (244). Keywords like "autism" (235), "multiple sclerosis" (226), "oxidative stress" (220), and emerging technologies such as "deep learning" (216) and "machine learning" (156) are also notable. Terms such as "quality of life," "children," and "molecular docking" reflect diverse areas of research interest. This visualization highlights key themes and evolving priorities within the field.

Advancement of Saudi research in disability

Figure 6 illustrates the thematic evolution of Saudi disability research across three phases analyzed using the R package. The transition to 1961-2018 indicates a strong focus

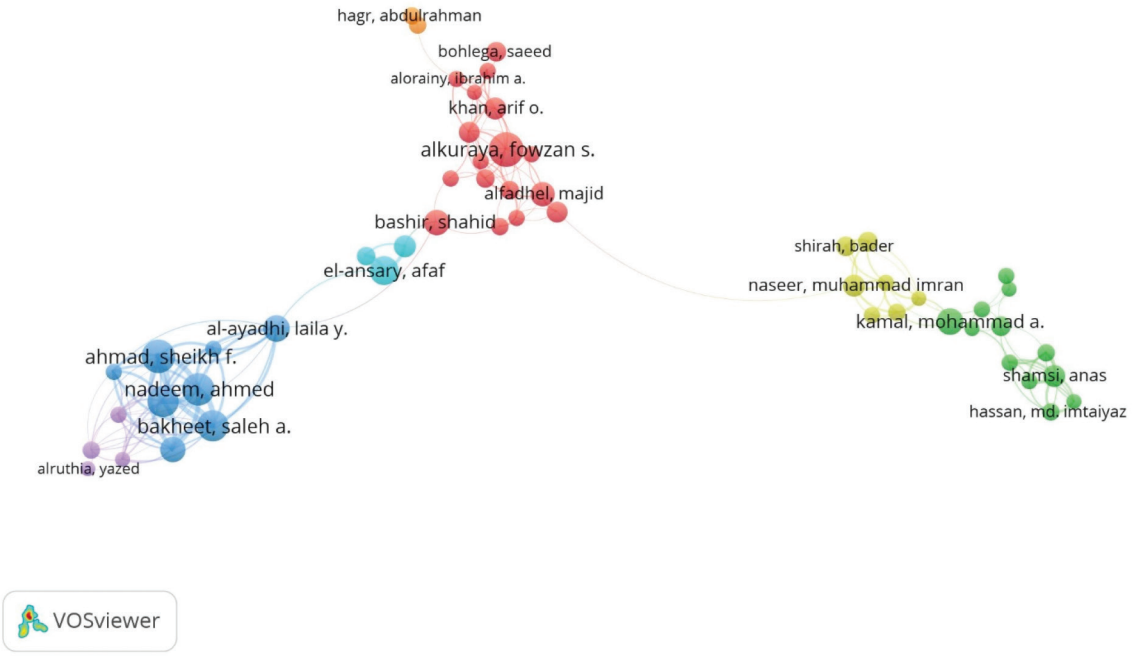

Figure 4: The most collaborative authors in Saudi disability research. The figure presents the most collaborative authors based on total link strength (TLS), led by Ahmad, S.F. (399), Nadeem, A. (395), and Bakheet, S.A. (389). TLS reflects the strength of co-authorship networks, emphasizing the collaborative landscape of Saudi disability research.

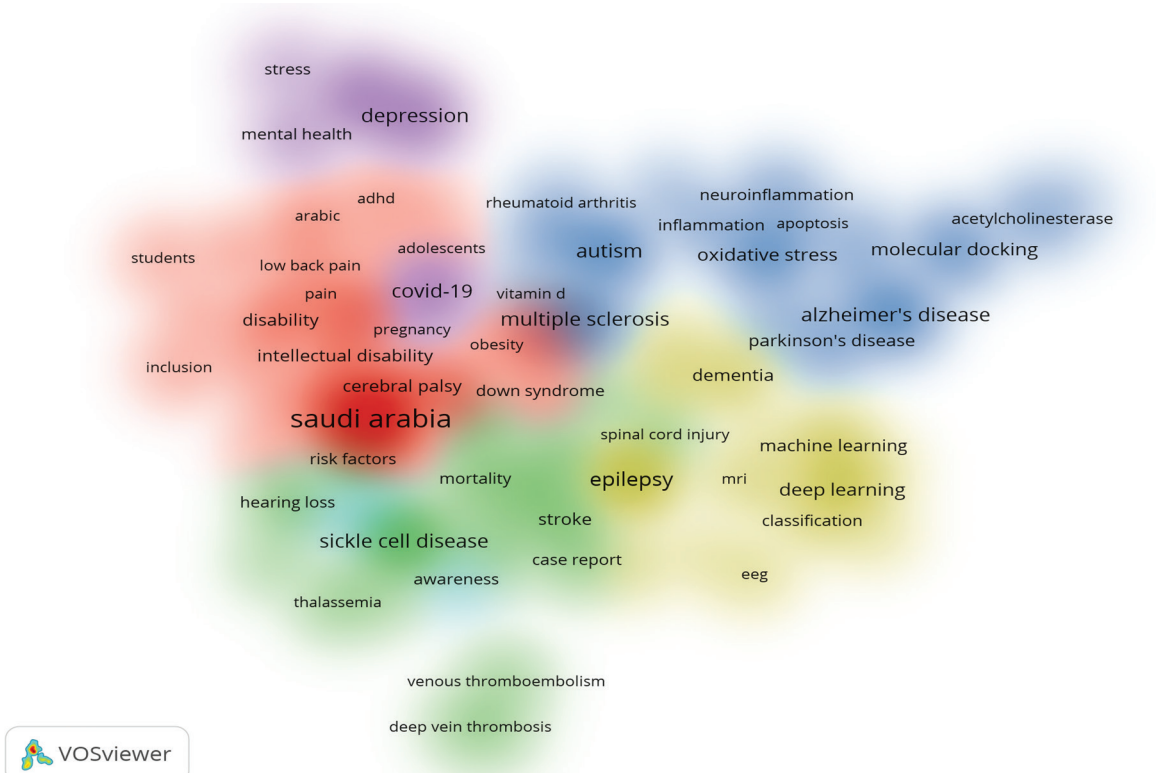

Figure 5: Word cloud depicting the most frequently used author keywords.

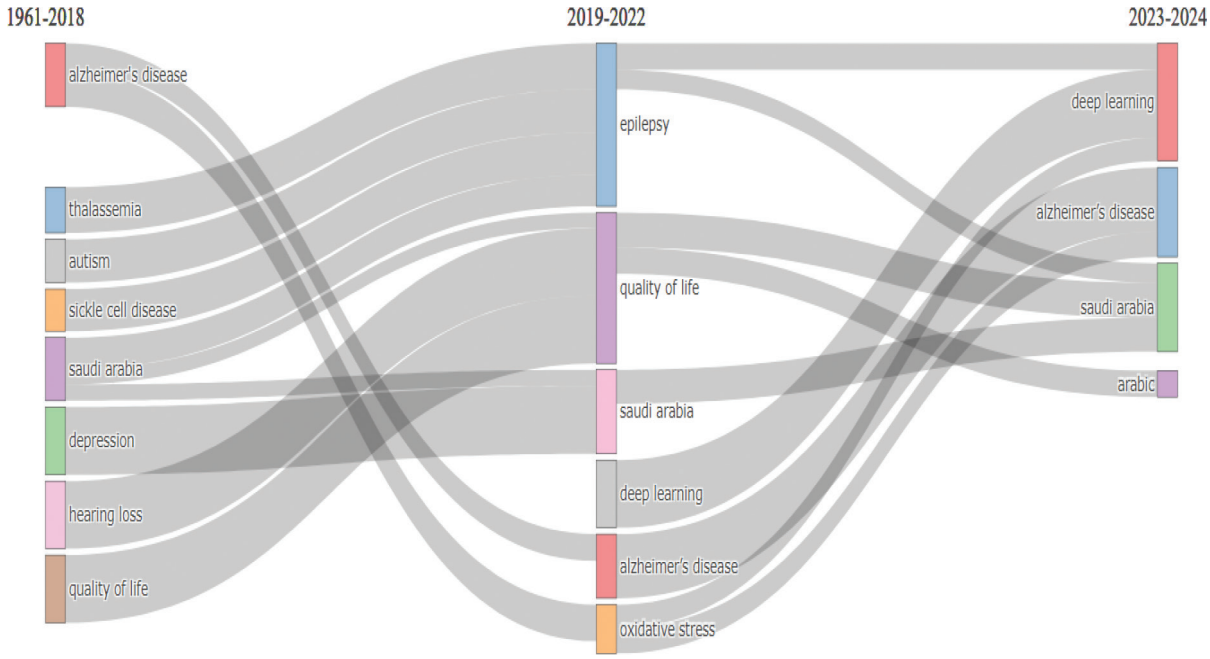

Figure 6: Thematic evolution of Saudi disability research across three phases (1961-2018, 2019-2022, and 2023-2024). The analysis was conducted using the R package bibliometrix to map emerging and evolving research themes.

on topics such as Alzheimer's disease, autism, depression, and hearing loss, with research evolving toward "quality of life" and "Saudi Arabia" as key areas. During 2019-2022, themes shifted toward emerging issues, including "epilepsy," "oxidative stress," "deep learning," and continued emphasis on "Alzheimer's disease" and "quality of life." In the most recent phase, 2023-2024, there is a noticeable focus on technological advancements like "deep learning" and themes such as "Arabic" and "Saudi Arabia," reflecting a broadening scope and integration of contemporary challenges and

Table 6: Key research themes identified in disability research.

Cluster label	Callon centrality	Callon density	Terms	Classification of the research theme
Disability	0.002	0.671	Disability	Emerging or declining theme
Saudi Arabia	0.014	1.129	Saudi Arabia, quality of life, children, prevalence, cerebral palsy, stroke, knowledge, hearing loss, risk factors, traumatic brain injury, rehabilitation, epidemiology, mortality, down syndrome, awareness, case report, obesity	Motor theme
Alzheimer's disease	0.015	1.031	Alzheimer's disease, oxidative stress, dementia, neuroinflammation, Parkinson's disease, inflammation, neurodegeneration, antioxidant	Motor theme
Deep learning	0.004	1.151	Deep learning, machine learning, classification, diabetic retinopathy	Niche theme
Epilepsy	0.015	0.947	Epilepsy, autism, multiple sclerosis, autism spectrum disorder, intellectual disability, schizophrenia, diabetes, diabetes mellitus, seizure, seizures	Basic theme
Molecular docking	0.003	0.882	Molecular docking, acetylcholinesterase	Emerging theme
Sickle cell disease	0.001	1.002	Sickle cell disease, thalassemia	Niche theme
Depression	0.009	0.988	Depression, anxiety, COVID-19, mental health, stress	Basic theme

Abbreviation: COVID-19, coronavirus disease 2019.

innovations. This progression highlights the dynamic growth and adaptation of disability research in Saudi Arabia.

Major themes

The major themes in Saudi disability research, as outlined in Table 6, were categorized into motor, basic, niche, and emerging or declining themes. The motor themes included Saudi Arabia (centrality 0.014, density 1.129) and Alzheimer's disease (centrality 0.015, density 1.031), with a focus on quality of life, children, neuroinflammation, and dementia. The basic themes included epilepsy (centrality 0.015, density 0.947) and depression (centrality 0.009, density 0.988), covering areas such as autism, mental health, and stress. Niche themes, such as deep learning (centrality 0.004, density 1.151) and sickle cell disease (centrality 0.001, density 1.002), highlight specialized topics, such as machine learning and thalassemia. The emerging or declining themes included disability (centrality 0.002, density 0.671) and molecular docking (centrality 0.003, density 0.882), reflecting areas of evolving or reduced focus. This thematic analysis illustrated the diversity and progression of research priorities in disability studies in Saudi Arabia.

Trending topics

Figure 7 presents an overlay visualization of the most co-occurring keywords in Saudi disability research, created using VOSviewer (v.1.6.19) for a sample size of N = 13,246. The visualization uses node colors to represent the time since publication, with yellow and light green nodes indicating trending topics. The emerging and trending topics include students, coronavirus disease 2019 (COVID-19), mental health, molecular docking, machine learning, deep learning, neuroinflammation, apoptosis, inclusion, awareness, obesity, and attention deficit hyperactivity disorder (ADHD). This overlay highlights the recent focus and evolving priorities within Saudi disability research, showcasing a shift toward modern challenges and technological advancements.

DISCUSSION

Saudi Arabia's contribution of approximately 0.54% to global disability research reflects its growing but modest role in this important field. With 17,166 publications out of a global total of 3,183,950, Saudi Arabia has made significant progress in advancing disability research, particularly in the context of national priorities and Vision 2030 goals [6]. This contribution highlights the country's increasing focus on addressing local and global challenges related to disabilities through research and innovation. However, the proportion suggests room for growth in alignment with global research output, especially given the increasing prevalence of disabilities worldwide and the need for localized, culturally relevant solutions. Saudi Arabia's research landscape, supported by international collaborations (with a co-authorship rate of 59.53%), shows strong potential to expand its influence and impact. Future efforts should focus on increasing the volume and quality of publications, fostering interdisciplinary research, and targeting underrepresented areas within disability studies to enhance the global research footprint. This study aligns with prior research [4, 18] in Saudi Arabia on disabilities and has the potential to substantially improve the lives of those with disabilities.

Alkuraya, is recognized as the most productive and impactful author of Saudi disability research, with significant contributions to the fields of genomics and genetic disorders. His work focuses on leveraging next-generation sequencing technologies, including exome and genome sequencing, to uncover the genetic underpinnings

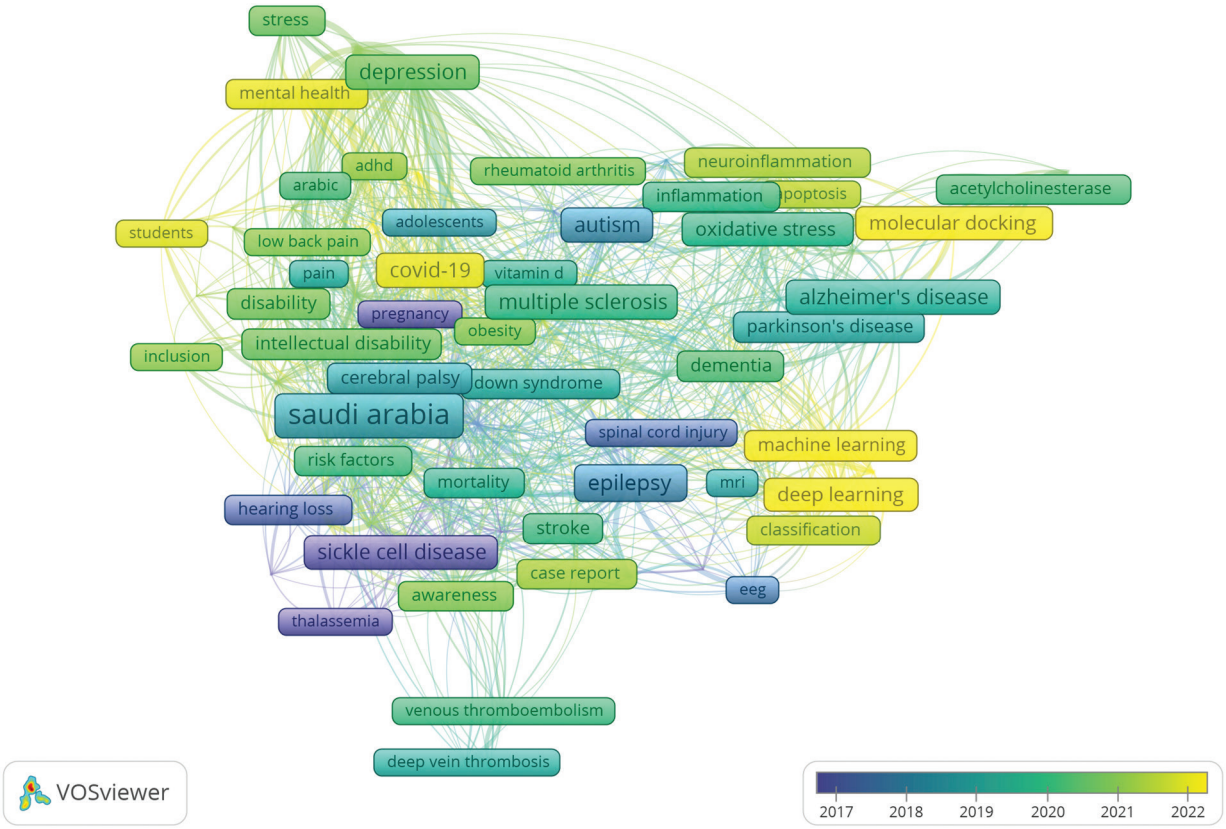

Figure 7: Overlay visualization of the most co-occurring keywords [created using VOSviewer (v.1.6.19) for the sample *N* = 13,246], where the score of each item represents the time since publication. Yellow and light green nodes indicate trending topics. The emerging and trending topics include students, coronavirus disease 2019 (COVID-19), mental health, molecular docking, machine learning, deep learning, neuroinflammation, apoptosis, inclusion, awareness, obesity, and attention deficit hyperactivity disorder (ADHD).

of hereditary diseases prevalent in consanguineous populations, particularly in the Middle East [19-28]. For instance, this study identified pathogenic mutations and novel candidate genes in retinal dystrophy, highlighting the utility of autozygome-guided exome sequencing [19]. Alkuraya et al. emphasized the diagnostic power of genomic tools in providing accurate molecular diagnoses, such as in intellectual disabilities, where exome sequencing revealed novel candidate genes such as *DENND5A*, *NEMF*, and *DNHD1* [22]. He identified recessive mutations in *ELOVL4*, linking them to neuro-ichthyotic diseases, and emphasized the importance of very-long-chain fatty acid synthesis [21]. Additionally, his work on mitochondrial encephalopathies uncovered novel mutations in *FARS2* that directly impair mitochondrial tRNA function [23]. In another study, Alkuraya et al. explored a large cohort of Middle Eastern patients with Mendelian disorders, achieving a diagnostic yield of 60% using clinical exome sequencing and uncovering novel disease genes such as *MANF* and *GLG1* [28]. Furthermore, he demonstrated the role of balanced chromosomal abnormalities in congenital anomalies through whole-genome sequencing, offering insights into their pathogenic mechanisms [25]. Through his prolific research, Alkuraya, has significantly expanded the morbid genome, elucidated the genetic mechanisms underlying rare disorders, and advanced precision medicine in Saudi Arabia and worldwide. His pioneering work has shaped our understanding and diagnosis of genetic diseases.

The patterns presented in Figure 6 show clear changes in the areas of research focuses for Saudi research on disability in chronological order. Early focus (1961-2018) on foundational topics such as Alzheimer's disease [29], autism [30], depression [31], and hearing loss [32] indicates a period of groundwork, emphasizing the understanding of prevalent conditions and their impact. This period laid the foundation for addressing basic and critical issues in disability research. The second phase (2019-2022) refers more to challenges such as changing demands and applying sophisticated technologies. The upsurge in themes such as epilepsy [33] and oxidative stress [34] must mean that research has begun moving toward biochemical dimensions of disability alongside applying inventive approaches such as deep learning [35]. Similar acknowledgment of quality of life and Alzheimer's disease further showed that the focus of the patients' effectiveness and age-related diseases did not shift during this stage. The last phase expanded the range of activities, focusing on the fact that Saudi Arabia has begun to pursue contemporary themes in research since 2023. The expansion of topics such as deep learning and Arabic [36, 37] also shows how researchers try to create relevant research in the region while simultaneously

using the latest technology to solve issues of language and culture, thereby addressing regional gaps in disability research. In conclusion, this research shows the evolution of Saudi Arabia, allowing it to realign its research priorities toward changing demands without losing sight of the local context or addressing local challenges. Thematic evolution enhances a country's purpose of developing relevant and transformative innovations in the field of disability research that respond to the needs of both the country and society [16]. Saudi Arabia needs to invest in new technology, interdisciplinary research, and research appropriate for the culture to enhance its output.

The thematic map depicted in Table 6 is quite helpful in understanding the breadth and development of disability research in Saudi Arabia but has some shortcomings. It does not capture crosscutting themes well, for almost all areas such as "quality of life" and "mental health" would have connections to motor and basic themes, respectively, on a wider interdisciplinary level. There is an excessive focus on technological niche themes that include "deep learning" and "molecular docking" without sufficient inquiry into their potential in solving fundamental disability issues, such as accessibility and health care. The map also fails to consider relevant sociocultural elements that are inherent in Saudi Arabia, such as language issues, cultural stigmas, and policy issues, which are important in understanding disability research in that area. The emerging themes that are included such as "inclusive education" and "assistive technologies" and the lack of time perspective make it nearly impossible to examine the emergence or the decline of the themes in history. This suggests the need for a more comprehensive and dynamic view to explain the development of this field.

As shown in Figure 7, machine learning is a trending theme in Saudi disability research with diverse applications across neurological disorders and disability management. Alahmadi et al. (2024) and Alshamlan et al. (2024) applied machine learning to predict mild cognitive impairment and Alzheimer's disease [38, 39], respectively, while Ayub et al. (2024) enhanced early autism detection [40]. Advanced models for Parkinson's disease [41] and gait freezing detection [42] have demonstrated their roles in neurorehabilitation. De Brouwer et al. (2024) utilized machine learning to predict disability progression in multiple sclerosis [43], and Khan et al. (2024) linked biomarkers for Alzheimer's diagnosis [44]. Applications extend to drug discovery, with Zulfat et al. (2024) identifying epilepsy treatments and Islam et al. (2024) screening Alzheimer's drugs [45, 46]. Torad et al. (2024) used machine learning to analyze predictors of neck disability [47]. These studies highlight the transformative impact of machine learning on diagnostic, rehabilitation, and therapeutic innovations in disability research.

LIMITATIONS

This study used Scopus as the primary data source because of its multidisciplinary scope and extensive indexing. However, Scopus and its English-only focus have certain limitations, including insufficient citation coverage for regional and local studies published in non-indexed journals, the exclusion of Arabic language publications, and potential publication bias. Additionally, Scopus has subject-specific limitations and may omit certain relevant fields, particularly those underrepresented in international research databases. Errors such as data entry inaccuracies and inconsistent indexing further limit the comprehensiveness of the dataset. To address these limitations in future studies, researchers are encouraged to integrate additional databases, such as PubMed for medical studies and Web of Science for broader citation comparisons. Incorporating articles published in other languages, collaborating across regions, and exploring national reports and regional reviews can provide a holistic perspective. These measures will enhance the robustness and reliability of bibliometric analyses in disability research.

CONCLUSIONS

This bibliometric analysis of disability research in Saudi Arabia provides valuable insights into the field's development, trends, and global impact. The study highlights significant Saudi contributions, with over 13,000 data-driven publications, a robust international co-authorship rate of 59.53%, and a focus on impactful themes such as Alzheimer's disease, epilepsy, and deep learning. Key findings include the dominance of original research articles, the identification of motor themes like "quality of life" and "Saudi Arabia," and the emergence of trending topics such as mental health, COVID-19, molecular docking, and machine learning. Despite these achievements, gaps remain in the literature, including a lack of focus on underrepresented conditions such as rare genetic disorders, sensory disabilities, and behavioral disorders. Research on accessibility, disability-inclusive education policies, and workplace inclusion is also limited. Regional disparities in disability-related research outputs within Saudi Arabia and the integration of the lived experiences of individuals with disabilities into research designs require attention. To advance the field, future research should prioritize these underrepresented topics and adopt interdisciplinary methods, leveraging emerging technologies to address modern challenges. Expanding collaboration with international institutions, fostering equitable regional contributions, and integrating policy-driven studies can enhance the societal impact of disability research in Saudi Arabia. These recommendations aim to support a more comprehensive and impactful research agenda that aligns with global trends and national priorities.

The findings of this study have significant implications for individuals with disabilities and the broader research community. They highlight existing disparities in disability research and resources, raising awareness among stakeholders, and potentially influencing public and private sector initiatives. Bibliometric analysis serves as a valuable tool for advocacy groups to identify and prioritize areas

requiring urgent attention and supporting strategic planning and action. Policymakers can leverage these results to advocate for increased funding and targeted investments in underexplored areas of disability research, thereby fostering a more equitable research landscape. Additionally, this study identifies opportunities for future empirical research to address critical needs in Saudi Arabia, providing a road map for researchers to expand and focus their work effectively. These insights emphasize the importance of aligning research efforts with the needs of disabled individuals to promote meaningful impacts.

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DATA AVAILABILITY STATEMENT

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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