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Examination of Research on Developmental Delay, Identification, and Early Intervention: A Bibliometric Analysis

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Abstract

Early intervention has been described as a systematic and deliberate effort to encourage development by influencing environmental or experimental factors. These interventions are initiated within the first five years of life. In recent years, there has been a significant increase in studies encompassing early intervention, developmental delay, and diagnosis. However, bibliometric studies on this topic remain limited. This article aims to analyze research on early intervention, developmental delay, and diagnosis published on the Web of Science (WoS). The analysis and visualization of selected documents were conducted using VOS viewer. A bibliometric analysis of 390 academic studies published between 1991 and 2023 was performed, with one study excluded, resulting in the examination of a total of 389 articles. Most of these articles cover areas such as pediatrics, developmental psychology, and related fields. The year 2022 was identified as having the highest number of publications and citations for articles published since 1991. One of the most cited articles focuses on the prevalence of autism spectrum disorder. The country with the highest number of article publications is the United States. Overall, the five most used keywords in the research are 'early intervention, developmental delay, early diagnosis, autism, and screening.

Keywords: Early intervention, Developmental delay, Identification.

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Gelişimsel Gecikme, Tanılama ve Erken Müdahale Konulu Araştırmaların İncelenmesi: Bibliyometrik Bir Analiz

Özet

Erken müdahale, çevresel veya deneysel faktörleri etkileyerek gelişimi desteklemek için sistematik ve kasıtlı bir çaba olarak tanımlanmıştır. Erken müdahaleler, yaşamın ilk beş yılı içinde başlatılmalıdır. Son yıllarda, erken müdahale, gelişimsel gecikme ve tanımayı kapsayan çalışmalarda önemli bir artış olmuştur. Ancak, bu konudaki bibliyometrik çalışmalar sınırlı kalmaktadır. Bu makale, Web of Science'ta yayımlanan erken müdahale, gelişimsel gecikme ve tanı konularındaki araştırmaları analiz etmeyi amaçlamaktadır. Seçilen belgelerin analizi ve görselleştirilmesi VOS viewer kullanılarak gerçekleştirilmiştir. Bu çalışmada 1991 ile 2023 yılları arasında yayımlanan 390 akademik çalışmanın bibliyometrik analizi yapıldı, bir çalışma hariç tutuldu ve toplamda 389 makale incelendi. Bu makalelerin çoğunluğu pediatri, gelişim psikolojisi ve ilgili alanlar gibi konuları kapsamaktadır. 2022 yılı, 1991'den bu yana yayımlanan makaleler için en yüksek sayıda yayın ve makalenin yayımlandığı yıldan itibaren atıf yapılan yıl olarak belirlendi. En çok atıf yapılan makalelerden birinin otizm spektrum bozukluğunun yaygınlığına odaklandığı bulunmuştur. Makale yayın sayısının en yüksek olduğu ülke Amerika Birleşik Devletleri'dir. Genel olarak, araştırmada en sık kullanılan beş anahtar kelime 'erken müdahale, gelişimsel gecikme, erken teşhis, otizm ve tarama' olarak belirlenmiştir.

Anahtar Kelimeler: Erken müdahale, Gelişimsel gecikme, Tanılama.

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1. Introduction

Developmental delay can occur when a child does not reach normal developmental milestones at the expected age in areas such as motor skills, cognitive development, social-emotional development, or language development (Baker et al., 2010). Infants may be at risk for developmental disorders due to social or biological reasons. Multidisciplinary family health services may be necessary from birth to age 5 to support child health and minimize developmental delays (Shonkoff & Meisels, 2000).

1.1. Developmental delay

The prevalence of developmental delay varies across countries based on their developmental levels, yet it remains a condition with high incidence worldwide, necessitating intervention (Vitrikas et al., 2017). Developmental delays are pervasive in childhood, affecting 1-3% of preschool children (Bellman et al., 2013). Given the importance of early support, early intervention (EI) is defined as a systematic and planned effort to promote development during the early years of life (0-8 years). This effort encompasses family education to support the child, along with specific interventions and programs aimed at improving access to various support services in the health and social care sectors (McWilliam, 2016; Kaur et al., 2006). In 2014, only 3% of all children had access to public early intervention services by the age of three. Children residing in conditions marked by adversities, such as poverty and malnutrition, face a significantly elevated risk of encountering disabilities (UNICEF, 2013). Detection often occurs during routine check-ups by primary care physicians or when concerns are expressed by parents or preschools. Assessment for developmental delay involves multiple steps. The first step includes growth percentile measurements, hearing and vision tests, initial blood tests when necessary, and a physical examination, where communication with parents and timely intervention are vital (Choo et al., 2019). This is a process in which children with suspected developmental delay should be intervened in a timely manner with early diagnosis, supported by minimizing risk factors, and followed up longitudinally (Raines et al., 2012). Access to early intervention has been identified in the literature as a priority for developmental disability research (Collins et al., 2017). A significant part of children with developmental delays needs early diagnosis but may have difficulties accessing it. These difficulties include lack of access to specialists, waiting times, cultural factors and financial circumstances (Betz et al, 2004). To

overcome these challenges, early detection of developmental delays revealed by developmental screening in infants and young children in low- and middle-income countries is of great importance to enable early intervention and rehabilitation (Faruk et al., 2020). The necessity to align growth assessment tools both conceptually and pragmatically led to the convening of an expert group meeting in 2006. The purpose of this meeting was to assess the feasibility of creating a unified international growth reference for school-aged children and adolescents (Rydz et al., 2005; WHO, 2006). In recent years, due to greater awareness of developmental disabilities, improved access to health services, and changes in diagnostic criteria, the identification of children at developmental risk has increased (Olusanya et al., 2018). Greater clarity and guidance are needed regarding the criteria for qualifying children for Early Intervention (EI) services. Emphasizing that infants should be automatically referred for EI based on the likelihood of their Newborn Screening (NBS) results indicating a risk of developmental delay. This approach could expedite referrals for children with developmental delays and enhance access to EI services (Reynolds et al., 2023).

1.2. Early intervention

Research on the effects of early intervention on development has primarily focused on parent-to-parent interactions, the significance of early diagnosis, and the development of infant intervention programs. However, there is a notable gap in long-term studies examining the relationship between early intervention and developmental outcomes (Hadders-Algra, 2011). In summary, the WoS data provides valuable insights into the social and conceptual structure of research in the field by analyzing studies related to developmental delay, identification, and early development. This study conducted a comprehensive literature search of research articles published in the Web of Science using the keywords "developmental delay," "identification," and "early intervention" to perform a thorough scientific evaluation of the literature in these areas. The aim is to observe changes and developments over time and to assess the productivity of the field.

2. Method

2.1. Study Design

In this study, a bibliometric analysis method, which is a subcategory of systematic literature review, was employed. This approach includes measuring both publication and citation metrics

while also identifying key themes, patterns, and gaps in the field. Bibliometric analysis encapsulates the bibliometric and intellectual framework of a discipline by examining the social and structural interconnections among various research entities (e.g., authors, countries) (Donthu, et al.,2021). Many areas of early childhood development research that are linked to have already used bibliometric analyses. These areas include motor learning, language development, and neurodevelopmental disorders (Xu, et al.,2022; Guo, 2022, Chen et al., 2023). By incorporating sensemaking into bibliometric analyses, researchers can offer a more detailed view of the literature, enhancing the understanding of the current status, developments, and future directions within the discipline. This method helps to address common critiques of bibliometric studies, particularly those related to data being misinterpreted or insufficiently analyzed.

2.2. Data Sources

The bibliometric analysis was conducted on January 15, 2023. Articles from Dimensions were retrieved and assessed utilizing visualization tool VOS viewer.

2.3. Eligibility Criteria

Citation network analysis was carried out using bibliometric information obtained from the Web of Science. The search strategy employed was "Early intervention" [Topic] and "identification" [Topic] and "developmental delay" [Topic]. The publication limit was determined on a per-article basis, and one article has been exported for analysis. The research process is given in the Table 1 below.

Table 1

Research Process

Stage 1: Study Design	Database Selection	WOS (Web of Science)
	Index selection	Subject – related field indexes
	Document type	Article
	Language selection	English
	Date	1991-2023
	Keywords	"Early intervention'' and "Developmental delay" and "Identification*"
	Result	390 academic research
Stage 2: Data Preparation	Data cleaning	Based on the relevant index selection
Stage 3: Data Analysis	Bibliometric analysis	Characteristics of the Studies Distribution of Publication Year Characteristics of the Most Cited Studies Distribution of Authors in Studies Distribution of Countries Involved in Studies Distribution of Research Areas Co-word Analysis Bibliographic coupling analysis

2.4. Data Extraction

One article has been exported due to retracted publication. Retraction typically occurs when there are significant problems related to the research, data, methodology, or ethical considerations associated with a publication. Reasons for retractions can include issues such as data fabrication, plagiarism, ethical misconduct, errors, or other serious flaws that undermine the integrity and reliability of the study.

2.5. Experimental Setup

In the scope of this research, the Web of Science database provided by Clarivate Analytics in 2022 was utilized. Web of Science, with a history dating back to the 1960s, originated from the Science Citation Index developed by Eugene Garfield and is a product of "WOS (Web of Science) Thomson Reuters Institute of Scientific Information (ISI)." This comprehensive and multidisciplinary database encompasses over 20,000 journals and other publications. Researchers can conduct document reviews within the framework of their specified questions,

analyzing sources (books, theses, articles, conference papers, etc.) in the Web of Science database in terms of bibliometric parameters (Aghaei Chadegani et al., 2013). Bibliometric analysis provides maps and perspectives that reveal relationships and interactions among scientific elements, such as citation analysis, co-citation analysis, co-authorship analysis, bibliography matching, and co-word analysis (Öztürk & Gürler, 2021).

2.6. Data Analysis

In the study, the dataset of 389 research articles, accessed with the aim of examining research on developmental delay, identification, and early intervention until January 15, 2023, was analyzed in detail using bibliometric analysis techniques. The obtained data were organized based on the subcategories of the study and visualized using the VOS viewer software package through the creation of graphs.

3. Results

3.1 Characteristics of the Studies

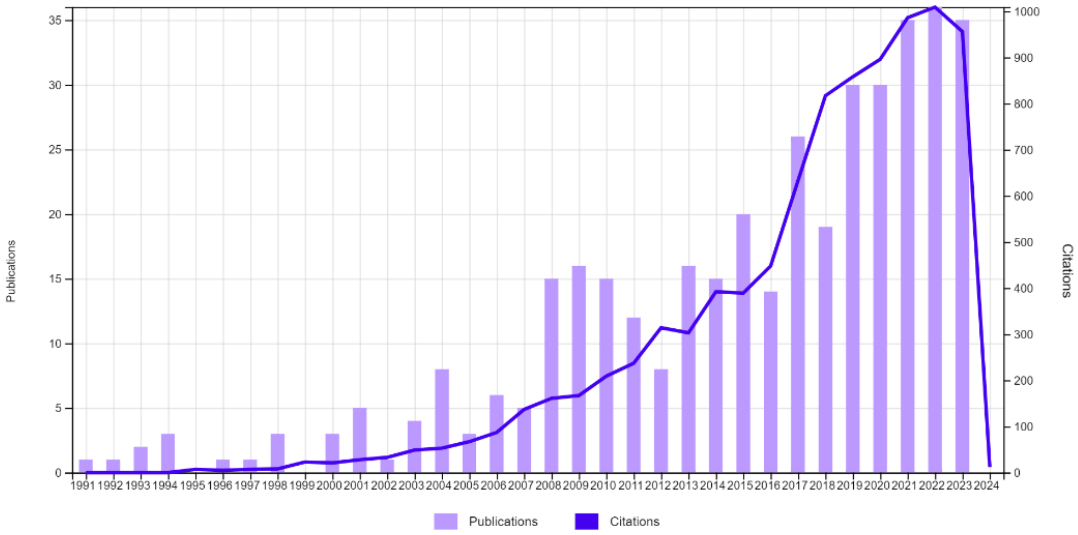
Based on the collected data, a total of 390 articles were identified from 1991 to 2024, published in English (372 articles), German (8 articles), Spanish (6 articles), Korean (2 articles), French (1 article), and Italian (1 article). One retracted publication was excluded from the study group. These articles cover a wide range of research areas, including pediatrics, developmental psychology, rehabilitation, special education, public and environmental health, occupational health, and clinical neurology.

3.2 Distribution of Publication Year

The year 2022 has been identified as the year with the highest number of publications, and no articles were published in research journals in 1995. When considering the citation trend line, there is an upward trend in the number of citations in the articles, reaching its peak in 2022 with 1009 citations. Publication years are shown in Figure 1.

Figure 1

Publication year

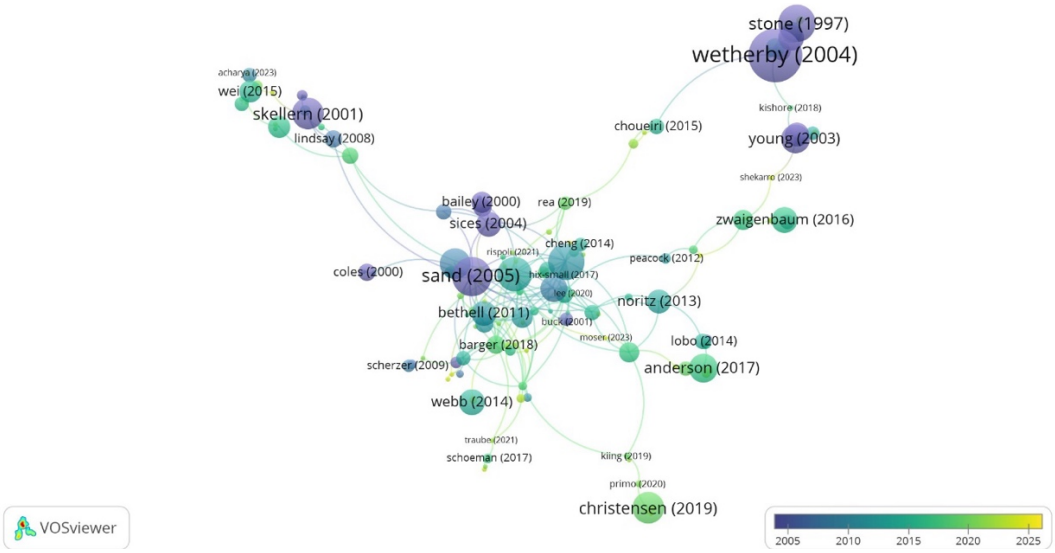


3.3 Characteristics of the Most Cited Studies

When the articles are arranged in descending order based on their frequency, the top three most cited articles have been examined in detail in terms of citations (As can be seen in Figure 2). The three articles with the highest local citations are ranked as follows: "Prevalence and Characteristics of Autism Spectrum Disorder Among Children Aged 8 Years," published by Christensen and colleagues in 2016 with 757 citations, "Early Indicators of Autism Spectrum Disorders in the Second Year of Life," published by Wetherby and colleagues in 2004 with 366 citations, and "The Changing Purpose of Prader-Willi Syndrome Clinical Diagnostic Criteria and Proposed Revised Criteria," published by Günay Aygün and colleagues in 2001 with 313 citations.

Figure 2

Most cited studies



3.4 Distribution of Authors in Studies

The top three authors with the highest number of published articles are Von Suchodoletz and Wetherby with 6 articles each, and Barger with 5 articles. The research topics of all three authors are centered around language development disorders/delays and early identification.

3.5 Distribution of Countries Involved in Studies

Most studies have been published by three countries: the USA (n = 210), Australia (n = 29), and Canada (n = 27). As can be seen in table 2, the top three countries with the highest citation count for studies on the USA, Australia, and Canada are, respectively, the United States (n = 6850), the United Kingdom (n = 1026), and Canada (n = 801).

Table 2

Country-wise publication and total citation counts

Country	Publication counts	Total citation counts
USA	210	6850
Australia	29	631
Canada	27	801
India	19	144
England	16	1026
Germany	15	135
China	13	83
Taiwan	13	139
South Africa	11	108
Brazil	9	142
Austria	7	70
Italy	7	98
Israel	5	75
France	5	54

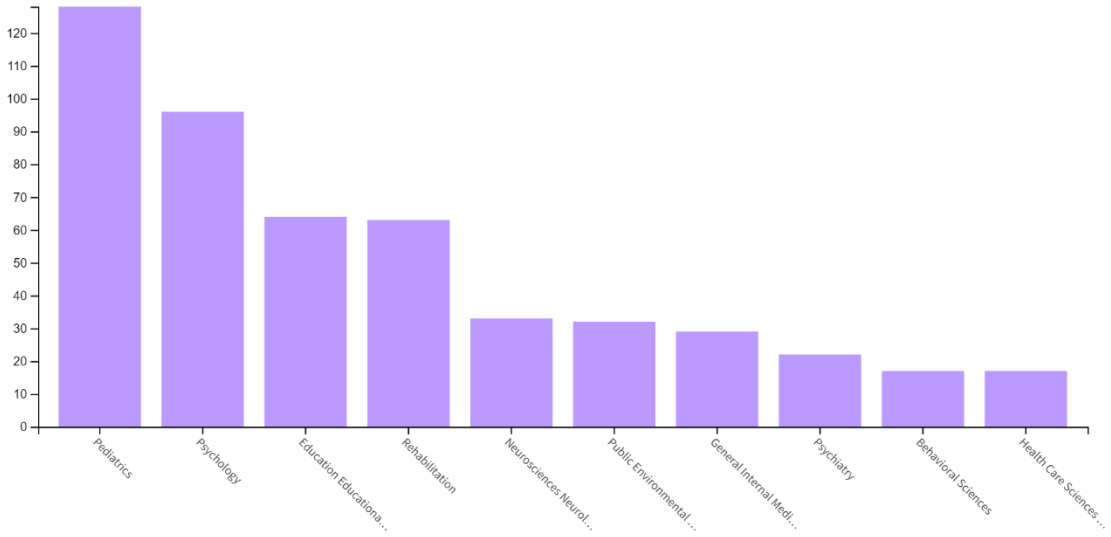
Country	Publication counts	Total citation counts
Sweden	5	15

3.6 Distribution of Research Areas

The top three significant sources are as follows: 128 articles in pediatrics, 72 articles in developmental psychology, and 62 articles in rehabilitation (as illustrated in Figure 3). The most cited article in the field of pediatrics is "The changing purpose of Prader-Willi syndrome clinical diagnostic criteria and proposed revised criteria" published by Gunay-Aygun and colleagues in 2001 with 128 citations. In the field of developmental psychology, the most cited article is "Early indicators of autism spectrum disorders in the second year of life" published by Wetherby and colleagues in 2004 with 72 citations. In the field of rehabilitation, the most cited article is "Sex differences in the evaluation and diagnosis of autism spectrum disorders among children" published by Giarelli and colleagues in 2010 with 62 citations.

Figure 3

Research areas



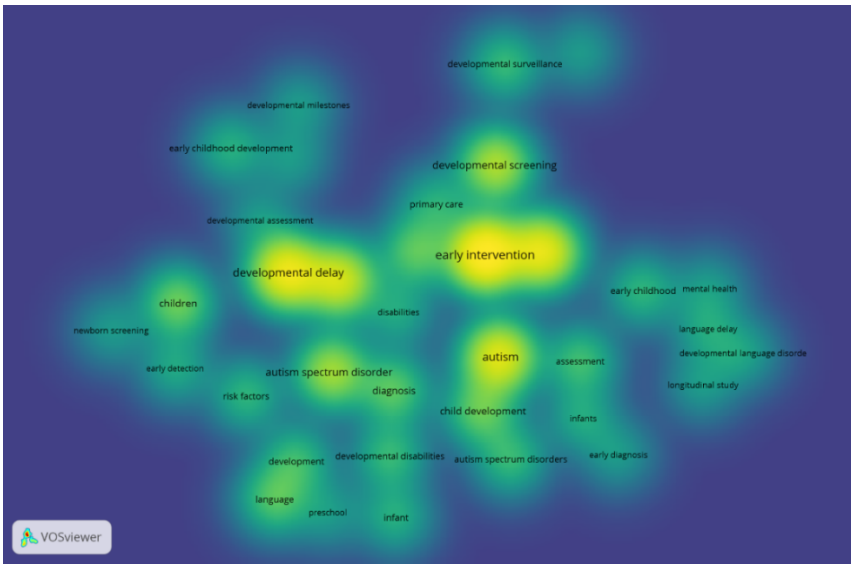
3.7. Co-word Analysis

In the visual representation of the co-keyword analysis density, when the threshold value for the least-used keyword is set to 5, chosen by the program, it is observed that out of 942

keywords, 36 have been used 5 or more times. In the density visualization, colors are arranged as follows: green represents the lowest density, yellow represents medium density, and red represents the highest density. Overall, the top five most frequently used keywords in the research are "early intervention, developmental delay, early identification, autism, and screening," appearing 54, 41, 38, 36, and 32 times, respectively (as shown in Figure 4).

Figure 4

Co word analysis

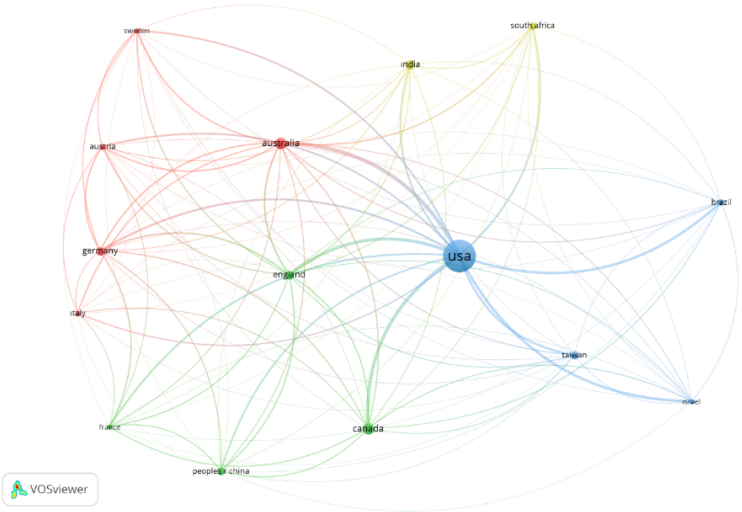


3.8. Bibliographic coupling analysis

Bibliographic coupling analysis involves systematically processing information and allows for the in-depth exploration of scientific data through the use of computer algorithms (Merigo et al., 2016). When using the same references, the similarity between articles can be assessed through bibliographic coupling (as seen in Figure 5). This analysis enables the revelation of the intellectual structure of emerging literature, facilitating a better understanding of current developments in the literature and deepening connections in the field (Kajikawa et al., 2007). Furthermore, it aids in monitoring and classifying current trends, while also offering insights into the network of relationships among authors, institutions, and countries that reference the same studies (García-Orozco et al., 2020)."

Figure 5

Bibliographic coupling analysis from a country perspective



Based on the bibliographic coupling analysis illustrated in the figure, the United States (US) stands out as the leading country where authors collaborating on research pertaining to developmental delay, diagnosis, and early identification have published the most articles. The US not only has the highest volume of publications but also plays a crucial role in advancing the field. Following the US, Australia, Canada, and India are also significant contributors.

4. Discussion and Conclusion

Bibliometric research has gained momentum in recent years, facilitating the identification of significant trends and gaps in research topics through bibliometric analysis (Donthu et al., 2021). A comprehensive literature review was performed using the keywords "early intervention," "developmental delay," and "identification" to examine the characteristics of published research in these areas. Understanding the features of these studies offers several advantages, including insights into current trends, the identification of future research directions, and information about the relationships among the most frequently studied topics and concepts (Bağış, 2021). Researchers have increasingly focused on the detection, intervention, and early identification of developmental delay. In recent years, there has been a consistent rise in the number of articles related to this topic. This research aims to comprehensively outline studies in the areas of early intervention, developmental delay, and diagnosis, incorporating bibliographic coupling analysis and co-word analysis.

The primary objective of research on early intervention, developmental delay, and identification is to explore strategies to address the fundamental issue of developmental delay.

Investigating the causal factors contributing to the observed delays in children is essential. Identifying a specific underlying etiology has significant implications for ongoing management, including estimating the risk of relapse, determining accurate prognoses, establishing mechanisms for medical follow-up, and, in rare cases, guiding specific therapeutic interventions (Shevell et al., 2001). Publications on this subject have demonstrated an upward trend from 1991 to the present, with a notable peak in the last two years. Notably, a screening study on the prevalence of autism spectrum disorder stands out among the most cited works (Christensen et al., 2016).

When looking at research output by country, the USA (n = 210), Australia (n = 29), and Canada (n = 27) stand out as leading contributors. There remains a lack of agreement on the most effective screening tools for identifying developmental disorders across various contexts. Although substantial strides have been made in developing, validating, and implementing screening tools for low- and middle-income countries, the majority of these tools were originally created in North America or Europe and are now applied in different cultural settings. While a shortage of validated tools for detecting autism in low- and middle-income countries persists (Soto et al., 2015). Various organizations, mostly in the United States, advocate for the screening of Autism Spectrum Disorders (ASDs), and the adaptation of screening instruments is on the rise. Research on childhood disability remains insufficient, particularly in low- and middle-income countries, despite its significant impact on child development, family dynamics, and economic factors (Maulik & Darmstadt, 2007). Besides, within-culture factors can restrict the validity of a tool, including differences in education levels, socioeconomic status, literacy, awareness of autism spectrum disorder and prejudgment (Soto, et al., 2015).

When examining the areas of research, it is evident that the majority of articles have been published in the field of pediatrics. This underscores the interdisciplinary nature of the investigation and intervention required in this field. The traditional categorization of young children may lead to premature labeling, mis categorization, and the under identification of children with delays who do not fit into conventional eligibility categories (Division for Early Childhood of the Council for Exceptional Children, 2001). This effect has been observed in past studies as well. Instead of simply associating with birth weight, it is feasible for primary healthcare providers to regularly conduct observations and developmental screenings (Poon et

al., 2010). The labeling of young children requiring early intervention services has been a subject of ongoing debate among parents, advocates, service providers, researchers, and policymakers for several years (Hadadian & Koch, 2013). The evaluation process of early childhood development is influenced by various risk factors. Additional risk factors that can arise in a school or community context include a strict curriculum, less opportunities for children to engage with one another, social isolation, and frequent exposure to violence (Hadadian & Koch, 2013).

4.1. Implications of Research

Key characteristics of modern education emphasize that it is more effective and cost-efficient when delivered at an early age compared to early intervention programs for children with general developmental delays (Singh & Anekar, 2018). In co-word analysis, in addition to the keywords "early intervention," "developmental delay," and "early intervention," the terms "autism" and "screening" stand out. This highlights the significance of research on autism in the context of early intervention. The presence of the keyword "screening" also indicates that screening results are crucial assessment elements in early intervention. Hence, various studies have been conducted to detect developmental delays in early childhood (Wallace et al., 2012; Goldfeld & Yousafzai, 2018).

4.2. Limitations and Suggestion

The primary aim of this study is to elucidate the intellectual structure of research on developmental delay, diagnosis, and early intervention and provide information about the research areas. Firstly, our analysis is solely based on the Web of Science database. While there is no limitation in terms of the starting point of the analysis in this study, the latest studies have been restricted to those available until January 15, 2023, which is the date of the last systematic literature review. For future studies, this time frame can be restructured by including publications from 2024 onwards. In this study, searches were conducted in the topic fields for the keywords "early intervention," "developmental delay," and "identification."

Addressing developmental delay is of the most importance for both families and society. However, there is a notable deficiency in high-quality studies examining the benefits of screening and the long-term effectiveness of treatment. Urgent research is imperative to identify optimal treatments for diagnosed developmental delay, leveraging promising findings

as a foundation. Additionally, valuable studies should evaluate effective strategies for developmental milestone surveillance and case identification. Primary healthcare providers play a crucial role in this context and should remain vigilant in monitoring a child's development during every clinical encounter, emphasizing developmental surveillance. Their focus should be on confirming the diagnosis of developmental delay among children who are suspected to be at risk, ensuring timely and appropriate interventions for improved outcomes.

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