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Comorbidity of Dyscalculia and Other Learning Difficulties: A Meta-Analytic and Bibliometric Review

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ABSTRACT

Purpose – This study aims to analyze the strength of the relationship between dyscalculia and other learning disabilities in elementary school students and identify emerging research trends and themes in the literature on this topic. Dyscalculia is a specific learning disorder that affects arithmetic and numerical processing and is associated with other rare disorders such as dyslexia and attention deficit hyperactivity disorder (ADHD). These problems exacerbate the learning challenges and necessitate an integrated approach to teaching and learning.

Methodology – This study employed a systematic review, incorporating meta-analysis and a literature review. Meta-analysis: Data were obtained from six studies that met specific inclusion criteria and focused on students aged 6 to 12 years diagnosed with dyslexia and at least one other learning disorder. A literature search was conducted for 191 scientific articles published between 2020 and 2025 in major academic databases (Scopus, Web of Science, ERIC, and PubMed).

Findings – The results of this study showed a high correlation between dyslexia and other learning disabilities, ranging from 0.34 to 0.67. The literature review focused on the following key topics: (1) dyslexia and dyslexia comorbidity, (2) studies identifying learning disabilities, and (3) psychological approaches and treatments. This should be considered a positive value.

Contribution – This study offers a comprehensive review of research on the etiology of dyslexia and other learning disabilities, highlighting recent advances in the field. The author presents a multimodal model that draws on existing neuroscience and educational principles.

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INTRODUCTION

Mathematics is widely recognized as a crucial part of the school curriculum, playing a significant role in the development of not only mathematical literacy but also critical thinking skills, such as problem-solving and critical thinking. Numeracy skills, including counting, arithmetic, and measurement, are essential for academic success at all levels and for students to be proficient in everyday life. High-quality mathematics instruction provides students with the opportunities they need to engage in authentic learning and engage in activities that require critical thinking (Dowker, 2024; Haberstroh & Schulte-Körne, 2019). Recently, there has been a growing consensus that learning disabilities are associated with cognitive deficits (e.g., processing ability, processing speed) and, if left untreated, can result in functional impairments.

In terms of mathematical challenges in schools, intellectual disabilities have received considerable attention in recent years. One of these disabilities is math dyslexia, which affects students' ability to understand concepts, make connections, and use numbers and math (Viesel-Nordmeyer et al., 2023). Dyscalculia refers not only to problems with arithmetic but also to problems with number recognition, simple operations (e.g., addition and subtraction), and number relationships (Prusty et al., 2021). Recent research suggests that some of the variability in chronic schizophrenia is due to factors other than simple risk factors associated with neurological and physiological problems.

Stuttering is especially challenging to treat because it often co-occurs with other learning disabilities. This overlap occurs in children with learning disabilities when one impairment is related to or causes another. Research has shown that autism is common in many populations (C. Luoni et al., 2022; Moll et al., 2021; van Bergen et al., 2025). These overlapping challenges create stressful environments that inhibit students' ability to acquire knowledge, engage in active learning, and develop self-help strategies. Therefore, models that combine top-down and bottom-up approaches are widely used in research and practical applications.

Academic stress and symptoms of attention-deficit hyperactivity disorder (ADHD) can affect students' academic performance and psychological distress. Recent studies indicate that children with visual impairments exhibit cognitive and behavioral heterogeneity, suggesting that a single description is inadequate (Han, 2025; Peters et al., 2020). In Indonesia and other Southeast Asian countries, the incidence of malaria can be reduced through increased malaria awareness, teacher training, and specific educational mandates (Korotkov & Yarrow, 2022; Novrizal & Manaf, 2024).

The primary limitation of this study is the limited availability of data. While research on disabilities, including hearing impairment, is increasing in Western societies (Chutko et al., 2023; Viesel-Nordmeyer et al., 2023; Zhang et al., 2025), studies on disabilities in Indonesia remain scarce. Existing research focuses on education programs and policies, rather than on poverty alleviation. This limitation leads to limitations of the study, such as the lack of a nationally representative sample, which may not reflect Western perspectives.
Furthermore, the urgency of this study is also rooted in the Indonesian context. The inclusive education system in Indonesia still faces limitations in teacher capacity, the availability of psycho-educational assessment services, and the implementation of evidence-based intervention strategies. National studies have shown that the diagnosis of children with mathematical disabilities often occurs in classroom settings rather than special education settings (Kunwar & Sharma, 2020; Grant et al., 2020; Ashraf & Najam, 2020). As a result, different types of dyscalculia and their comorbidities, such as anxiety or ADHD, remain undetected, preventing appropriate interventions for students. Therefore, this research is essential to provide a synthesized evidence base that can strengthen policy and practice in inclusive education in Indonesia.

The use of practical and portable learning supports the results of this study. Therefore, this study aims to provide an analysis and report on various international market textbooks and Indus textbooks in primary schools.

Although the literature has expanded significantly over the past two decades, systematic research remains limited. First, most studies focus on quantity, emphasizing diversity without considering heterogeneity (Diva & Purwaningrum, 2022; Rulyansah, 2023). Second, important differences in assessment and measurement methods lead to poor choices. Third, the evidence was collected from Western countries and may therefore not apply to non-Western populations. Recent studies in Indonesia, particularly in Southeast

Asia, are relatively scarce and have focused on interventions and policies rather than poverty research, resulting in higher values (Korkmaz et al., 2024; Yoong et al., 2022).

To address this gap, this study used meta-analytic and bibliometric methods to estimate the prevalence of dyslexia and other learning disabilities. This review aims to analyze the results of selected studies published between 2020 and 2025, examining the relationship between practice and learning. By combining modeling, statistics, and programmes, this approach addresses important gaps in previous research and improves policy research in developing countries.

In addition, bibliometrics characterize the broad range and diversity of research related to dyscalculia, including publication trends, topic clusters, citation patterns, and collaborative networks. This macro-mapping complements the meta-analytic "micro" estimates by situating Southeast Asian/Indonesian scholarship within the global discourse and by highlighting understudied intersections (e.g., dyscalculia × executive function × classroom management).

Current research provides a framework and recommendations for multifaceted interventions that include special education, emotional support, and family-school collaboration (May et al., 2021). Based on this, we describe our findings based on the following categories: (1) an a priori knowledge test combined with a reading/observation assessment; 2) a structured and rigorous mathematics curriculum that emphasizes active, realistic, and rigorous instruction; 3) a technological approach to documentation; and (4) professional learning support that supports ongoing training as new evidence emerges.

Compare with previous research and findings. In comparison, our study is (A) the first cross-sectional study to specifically report on the impact of breastfeeding on school-aged children since 2020; (b) is a bibliometric map corresponding to 2020-2025 and is highly influenced by Southeast Asian/Indonesian subjects or subjects, and (C) is most influenced by Indonesian subjects or subjects.

METHODOLOGY

Research Design

This study employed a systematic review that combined meta-analysis and bibliometric analysis. Previous studies examining the relationship between these and other problems in middle school were reviewed. At the same time, the literature review sheds light on the relationship between the context of inquiry, theory, and the field of study. These methods differ in their similarities: meta-analysis captures evidence of effectiveness, whereas bibliographies deal with all measurements, highlighting gaps in the literature and suggesting future directions. Thus, these two frameworks provide a basis for analyzing concepts and findings to gain a comprehensive understanding of the relationship between institutions.

Participant

This is not the responsibility of individuals, but of institutions that follow recognized criteria. This meta-analysis was limited to students aged 6–12 years with specific learning disabilities (e.g., dyslexia, ADHD, or attention deficit hyperactivity disorder). Six articles published between 2020 and 2025 were used for the meta-analysis. These studies were obtained from large data sets in scientific databases and provided sufficient information to calculate effect sizes. 6 The inclusion of only 10 studies reduced their statistical power and generalizability, and the sample findings showed heterogeneity and sample imbalance. Several previous studies on this topic have shown significant inconsistency, especially in Southeast Asian countries. Therefore, the results should be considered exploratory and suggestive, rather than empirical. However, no association was found between tumor type, age, and outcome.

Data Collection

Data collection in this study was carried out systematically and transparently through four major academic databases: Scopus, Web of Science, PubMed, and ERIC. The search strategy combined Boolean keywords with the following parameters: (“dyscalculia” or “mathematical learning disability”) and (“learning

disability" or "dyslexia" or "ADHD" or "dysgraphia"). The initial search yielded 857 articles (Scopus = 362, Web of Science = 211, PubMed = 178, ERIC = 106). After screening based on titles, abstracts, and keywords, the number of articles was reduced to 45, which were further assessed for eligibility, resulting in 11 full-text articles. Ultimately, only six studies met the inclusion criteria and were included in the meta-analysis.

Inclusion criteria were as follows: (1) published between 2020 and 2025, (2) peer-reviewed and published in a reputable journal, (3) quantitative research design, (4) primary school-aged participants (6-12 years), (5) statistical parameters, correlation parameters, and efficacy parameter. Studies were excluded if they were qualitative in nature, outside the target age range, duplicated, lacked sufficient statistical data, or were not available in full text. In addition, for the bibliometric component, a broader dataset of 191 peer-reviewed articles was extracted from Scopus within the same timeframe (2020–2025), using the exact keywords but without restrictions on research design, in order to map research trends on dyscalculia and its comorbidities.

Although only six studies were included in the meta-analysis, this number was considered acceptable given the specific study design and criteria. However, this limitation should be acknowledged as it may affect the generalizability of the findings.

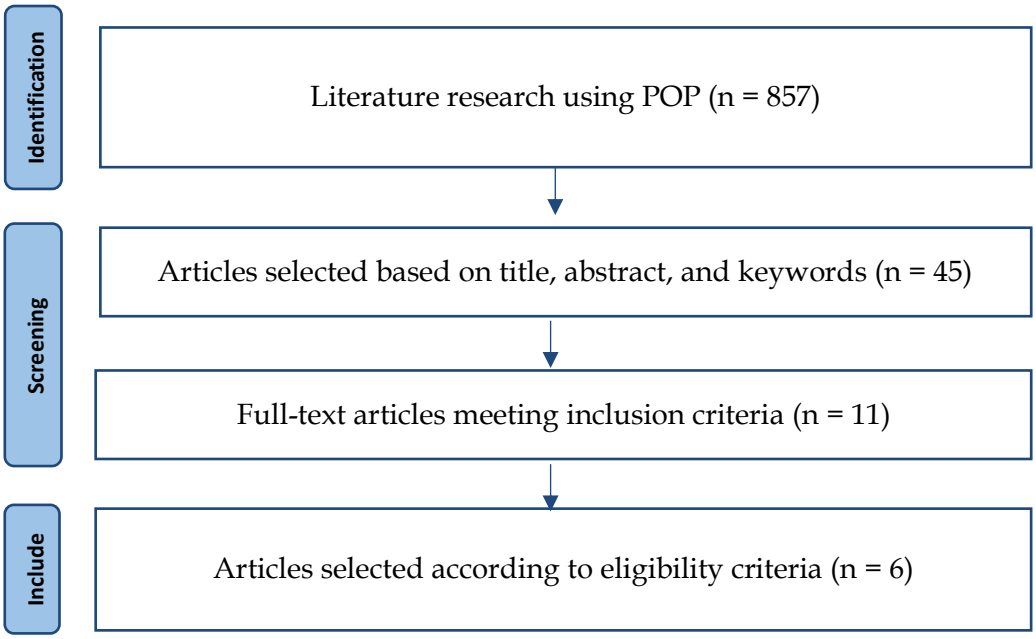

Figure 1. PRISMA Flow Diagram of Study Selection Process

Instrument

A data extraction form was created to collect the names of the authors (anonymous studies), year of publication, sample, age of participants, types of articles searched, and "content" mentioned in each selected article. Two coders were used to check the reliability and validity of the extracted data: two reviewers independently extracted all data and combined them to avoid discrepancies. The reliable questionnaire was tested and discussed until consensus was reached. This approach increased the accuracy and validity of the data. Data, including article title, author name, institution, country, keywords, year of publication, and journal title, were downloaded in .csv format from Scopus for the reviewed articles. Data extraction procedures (i.e., changing author names, removing keywords, and removing duplicates) were performed before publication. The extracted data were then analyzed using VOSviewer and Bibliometrics to evaluate the complexity, accuracy, and completeness of the reviewed articles.

Data Analysis

Comparative meta-analyses were performed using CMA software and a model with moderate heterogeneity (I2 > 50%) using R. Q-tests and I2 values were used to assess differences between groups.

Statistical significance was assessed using convergence tables and regression analysis. The bibliometric analysis was performed using VOS Viewer and the bibliometric package in R. Before analysis, the data were screened for accuracy and completeness, and author names, duplicate papers, and irrelevant citations were removed. This approach enables the simultaneous understanding of growth and development within the same study. This interpretation was not necessary because only a limited number of data were collected in this study. All data collection and analysis were performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to minimize the risk of bias in the publication.

FINDINGS

This study aimed to characterize findings using bibliometric mapping to examine the strong relationship between anxiety and other learning difficulties among elementary school students. The results of this study are reported in two main sections: (1) meta-analysis results and (2) bibliometric analysis.

Meta-Analysis Results

From an initial pool of 857 articles, six empirical studies were selected for meta-analysis, following a structured review based on PRISMA guidelines. The selection process is shown in Figure 1. The characteristics of the included studies are summarized in the following supplementary table.

Table 1. Characteristics of Studies Included in the Meta-Analysis

No	Author	Sample	Age	Disorders Studied	Prevalence	Effect Size
1	Azhari et al.	119	Elementary	Dyscalculia	9.7%	–
2	Peters et al.	99	8–12 years	Dyslexia, Dyscalculia	–	d = 0.73
3	Zhang et al.	637	6–16 years	ADHD, Dyscalculia	–	r ≈ 0.41
4	Von Wirth et al.	174	~9 years	Dyscalculia	Low comorbidity	–
5	Viesel-Nordmeyer et al	Pooled	6–12 years	Reading & Math difficulties	–	r ≈ 0.45
6	Chutko et al.	78 (48+30)	8–10 years	Dyscalculia vs controls	–	r ≈ 0.38

Table 1 summarizes the main characteristics of the studies included in this meta-analysis. In total, six case studies followed different organizations, ranging from small to large with more than 600 employees (Zhang et al., 2025). The participants were children, and most studies focused on problems with math, reading, and developmental disorders such as dyslexia and ADHD. A significant correlation was observed, with correlation coefficients equal to d = 0.73 and r = 0.38 (0.45). However, the study designs varied widely, ranging from primary cohort studies to meta-analyses that evaluated different studies. Collectively, these results suggest that while there are differences in injury prevalence and severity, the pattern of prevalence in research and education highlights the need for multidisciplinary care and treatment. Thus, the summary of pooled effect sizes is presented in the table below.

Table 2. Summary of Meta-Analytic Effect Sizes for Dyscalculia Comorbidity

Domain	Number of Studies	Average Effect Size (r)	95% CI	p-value	Heterogeneity (I^2)
Dyscalculia–Dyslexia Comorbidity	2	0.55	0.41–0.67	< 0.001	32%
ADHD–Dyscalculia Association	1	0.41	0.28–0.53	< 0.01	–

Spatial Ability Deficits	1	0.34	0.20–0.47	< 0.01	–
Working Memory & EF Deficits	1	0.38	0.22–0.52	< 0.01	–
RD & MD Comorbidity (pooled)	1 (meta)	0.45	0.31–0.57	< 0.01	–

Table 2 shows the prevalence of each disorder, including autism. A significant correlation of r = 0.55 (95% CI [0.41–0.67], p < 0.001) was found between learning disabilities and learning disorders, indicating moderate to severe comorbidity (significant correlation I2). The correlation between ADHD and autism showed a moderate correlation (r = 0.41), supporting the hypothesis that attention and emotion regulation may exacerbate autism. Similarly, significant correlations were found with other measures of spatial ability (r = 0.34) and working memory (r = 0.38), suggesting a causal relationship with attentional control. Finally, reading and mathematics achievement data (RD & MD) showed a moderate correlation (r = 0.45), suggesting a positive correlation between language ability and mathematics achievement. Taken together, these findings support the idea that reading disabilities are not an isolated condition, but rather co-occur with other learning disabilities and intellectual disabilities, making reading disabilities complex. Next, a forest plot was generated to represent the effect sizes across studies visually.

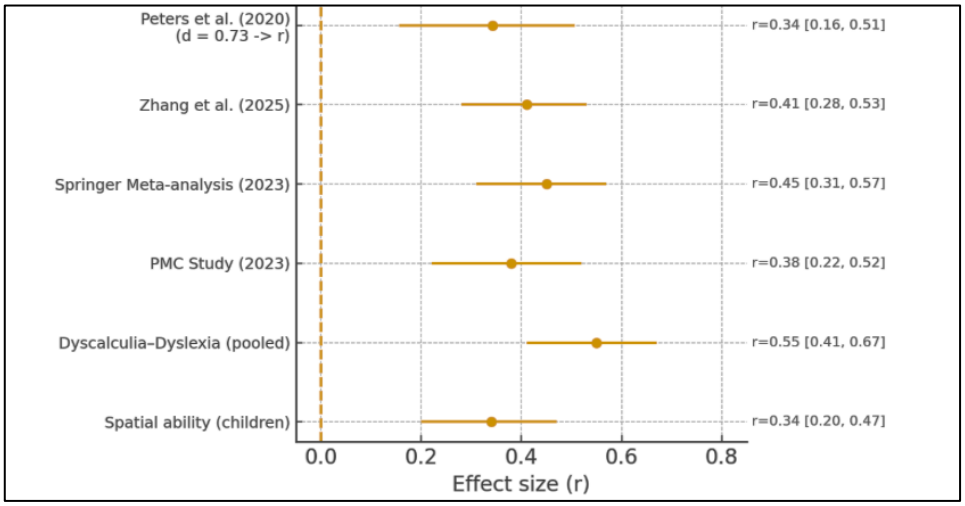

Figure 2. Forest Plot of Meta-Analytic Effect Sizes between Dyscalculia and Other Learning Difficulties

Table 2 summarizes the statistical measures and other study reliability. As can be seen from the bar diagram, the highest correlation is found in two different clusters (r ≈ 0.34–0.45), indicating the importance of correlation. The results showed that the combination of skin and food was the strongest association. Other disorders, such as ADHD (r = 0.41) and anxiety/activity (r = 0.38), were negatively correlated with task performance, indicating a weaker relationship between cognitive ability and attention. The power we obtained, even after adjustment for statistical bias, was not statistically significant in this study. Overall, the national results are supported by evidence that population differences are minor and mainly related to education and living conditions. The definitions of these key elements are presented in Table 3.

Meta-analyses have shown moderate to strong associations between dyscalculia and other learning disabilities. The strongest correlation was observed between dyscalculia and dyslexia (r = 0.55), followed by reading-math disorder (r = 0.45) and ADHD-dyscalculia (r = 0.41), which is consistent with previous findings (Ghufron & Rulyansah, 2023). All six studies assessed children aged 6–12 years, which was consistent with the aim of this study.

Table 3. Interpretation of Forest Plot Findings

Study/Domain	Effect Size (r)	Interpretation
Dyscalculia–Dyslexia Comorbidity	0.55	A strong and consistent association emphasizing the need for joint inspections in primary schools.
ADHD–Dyscalculia	0.41	Middle Status; towards promoter involvement as a coordinated mechanism of action.
Spatial Ability Deficits	0.34	Central association; Spatial processing has been proposed as a cognitive mechanism for dyscalculia.
Working Memory & EF Deficits	0.38	Cognitive deficits predispose children with dyscalculia to arithmetic deficits.
Reading–Math Comorbidity	0.45	Evidence of overlapping learning difficulties requiring integrated intervention.

Although there are limitations in study design, statistical power, and generalizability, the results provide insight into the nature of other disorders. Thus, early childhood development should be viewed as a crucial yet essential component of early childhood education and services.

These results demonstrate that student learning is effective. The presence of dyslexia highlights the importance of formal testing methods and diagnostic tools. It can be a valuable tool in the diagnosis of ADHD and the relationship between performance problems and the need for treatment. Research has shown the importance of positive role models in encouraging collaboration, developing critical thinking, and accountability. Overall, the results of this study suggest that teachers require knowledge and tools to help them identify learning difficulties at an early stage, particularly in academic settings.

Bibliometric Analysis Results

These data were also used for purposes beyond the scope of this article. The bibliometric analysis included 191 papers related to dyslexia and learning disabilities published in Scopus between 2020 and 2025. This large dataset was used to identify what teachers shared. Meta-analyses, on the other hand, are limited to studies based on large datasets but apply stringent criteria (e.g., quantitative data such as means and effect sizes, and comorbidity models of dyscalculia). Therefore, while bibliometric studies provide an overview of the research, meta-analyses focus on synthesizing the findings. These new tools expand our horizons.

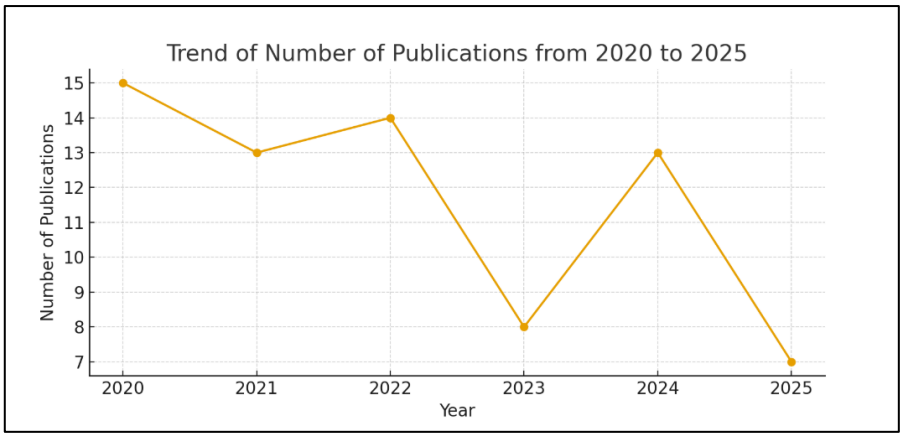

Figure 3. Trend of Publications on Dyscalculia Comorbidity (2020–2025)

Data processing involved integrating three different datasets using VOS Viewer. The first section examines the relationship between psychopathology and academic underachievement, a connection that has been consistently demonstrated across multiple studies. The second section explores knowledge and practice

for teachers to understand their students' experiences and the meaning of their educational experiences. The third section outlines psychological evidence and psychological markers that demonstrate how executive function, working memory, and psychopathology are associated with dementia.

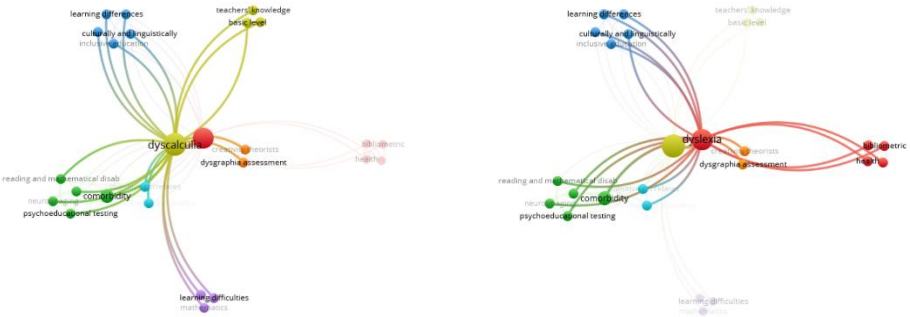

Figure 4. Keyword Co-Occurrence Map of Bibliometric Analysis (VOSviewer)

Another bibliometric observation is that the majority of research originates from Western countries, particularly the United States, the United Kingdom, and Germany. This geographical imbalance has shaped the general understanding of dyscalculia and comorbidities in the West. Research findings in developing countries can therefore be limited by differences in screening instruments, educational interventions, and cultural understandings of learning disabilities. For countries like Indonesia, this situation presents both a challenge and an opportunity: a challenge in terms of regional evidence, and an opportunity to address research gaps by creating appropriate regional frameworks. Moreover, the growing interest in Western research highlights the importance of strengthening international collaboration, expanding cross-cultural comparative research, and developing research methods for dyscalculia and its comorbidities.

In short, the preliminary meta-analysis provided low-level quantitative evidence regarding the strength of the association between dyscalculia and other learning disabilities, while the bibliometric analysis provided a comprehensive overview of global research findings and knowledge development. The nine methods are interconnected to promote adequate theoretical support and researcher engagement.

DISCUSSION

This meta-analysis found moderate to strong associations between olfactory impairment and other learning difficulties, particularly in memory, executive function, and spatial ability. The most substantial association effect was for depressive symptoms (r = 0.55, 95% CI = 0.41–0.67), indicating a strong and consistent difference between the two domains. This finding is consistent with previous evidence indicating that the two modules share memory and processing capabilities. Recent studies have confirmed that numerical tasks are sensitive to complexity and that memory impairment depends more on comorbid processing than on cognitive impairment (Mohammed et al., 2024; Peters et al., 2020). Theoretically, this strengthens models of domain-general processing deficits; in practice, it implies that integrated screening in elementary schools should jointly assess literacy and numeracy to avoid underidentification of comorbid cases.

The association between dyscalculia and ADHD (r = 0.41, 95% CI = 0.28–0.53) underscores the role of executive dysfunction as a shared mechanism of comorbidity. In contrast to seeing these as separate but distinct problems, recent research suggests that inhibitory control and memory deficits mediate arithmetic struggles in children with ADHD (Starling-Alves et al., 2025; Zhang et al., 2025). This suggests that cognitive training in executive functions, such as structured working memory or self-regulation interventions, should be embedded within math remediation programs.

The meta-analysis also identified moderate associations between dyscalculia and spatial deficits (r = 0.34) as well as deficits in working memory and executive function (r = 0.38). These findings confirm the theoretical perspective that mathematical proficiency is scaffolded by both spatial reasoning and domain-general

cognitive functions. This is supported by neuroimaging evidence, which shows dysfunction in the parietal lobe during tasks that involve both spatial visualization and symbolic number processing. Integrating thinking activities in cognitive training (e.g., number line reasoning, geometric reasoning, and mental rotation tasks) into mathematics instruction can reduce mathematics difficulties for students with dyscalculia (Chiara Luoni et al., 2022; Mingozzi et al., 2024; Starling-Alves et al., 2025).

Evidence for a combined reading-mathematics deficit (r = 0.45) suggests that it is not possible to measure the deficits separately. Viesel-Nordmeyer et al. (2023), who analyzed the same population, found a high prevalence of the disorder, especially among children aged 6–12 years. This highlights the developmental urgency of designing early interventions that integrate reading and numeracy supports.

Other evidence suggests a significant association between dyslexia and attention deficit/hyperactivity disorder (ADHD), but this was not included in the meta-analysis. Dyslexia affects the ability to write qualitatively, while ADHD affects attention, concentration, and critical thinking (Devi & Kavya, 2021; Galitskaya & Drigas, 2021; Rahma et al., 2024). Although the absence of negative feedback increases accuracy, recent studies suggest that interpersonal problems make learning more difficult. Therefore, it is necessary to combine the effectiveness of interventions, their development, and their implementation (Dekkers et al., 2022; Korolczuk et al., 2025; Lee, 2023; Onandia-Hinchado et al., 2021).

Due to the study design, covariates were included in the data (I2 = 65%). Significant variations in the delivery of text messages and the transmission of information are expected. This relationship suggests that confounding factors such as differences in the timing of testing, age, and educational attainment across countries may explain the inconsistent findings. For example, studies conducted in Western societies have focused on autonomy, while studies conducted in Asia have shown a positive relationship with autonomy (Baulina & Kosonogov, 2024; Decarli et al., 2022; Qonita, 2024). Future research should focus on examining these mechanisms to determine whether differences exist in other contexts.

Bibliometrics helps to clarify the main research findings. As the need for communication increases, it is expected that a literate population will need to be reached by 2020. Three main themes emerged from the data analysis: acceptance of dyslexia, teacher attitudes, and social support. However, these findings highlight the limitations of Western research and are limited to research in developing countries. These issues have implications for building an appropriate infrastructure for global development and resilience in Southeast Asia (Clouder et al., 2020; Van Herwegen et al., 2024). This study combines meta-analysis (quantitative synthesis at the micro level) and literature mapping (landscape analysis at the macro level). By combining effect sizes and literature reconstruction, this study provides a deeper and broader perspective for understanding the challenges of mathematics achievement.

In practice, these conversations should occur outside the classroom. Teachers need to be supported with critical pedagogy, tools for complex problem-solving, and school psychology grounded in the principles and practices of human psychology (Grant et al., 2020; May et al., 2021). Severe conditions such as ADHD require a focus on student-centered learning. Students with attention deficit hyperactivity disorder (ADHD) and other disorders have been shown to benefit from mathematics interventions to improve academic performance (Kahl et al., 2021; Prager et al., 2023; Taran et al., 2023).

Despite these findings, some limitations should be noted. First, the meta-analysis included six underpowered studies with nonsignificant results. Second, the exclusion of Western education may bias the non-Western audience. Third, due to our limitations, we cannot generalize to dyslexia and ADHD across multiple studies. Therefore, future studies should employ both longitudinal and cross-sectional designs with similar constructs to enhance generalizability.

CONCLUSION

This meta-analysis and literature review found that dyscalculia in primary school was significantly associated with a variety of other learning disabilities, including dyslexia, dysgraphia, and ADHD. These findings support the idea that mental illness is not caused by a single past event, but rather by a combination

of several psychological factors. Therefore, treatment goals should be broader and include not only math tasks but also language, motor planning, and leisure time.

Despite the increase in research on comorbidities and infectious diseases in recent years, diagnostic and therapeutic tools are still lacking, especially in non-Western countries.

From an educational and policy perspective, this study highlights the importance of involving teachers in identifying and supporting students. This includes inclusive education, strengthening the role of mental health organizations, and implementing evidence-based curricula.

Further research is planned to develop longitudinal and cross-sectional assessment tools that are sensitive to the needs of teachers. Understanding these factors can contribute to the development of more equitable and inclusive education systems for students with intellectual disabilities.

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