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Dysgraphia: Understanding, current detection, challenges and future scope

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Abstract

Dysgraphia, a subtype of specific learning disorder, impairs handwriting and written expression, often affecting academic success, self-esteem, and daily functioning. Despite recognition in diagnostic manuals, it remains under-identified, particularly in mainstream schools. This paper explores its clinical features, detection practices in Malaysia, and challenges faced by individuals, including academic, emotional, systemic, and diagnostic barriers. Emerging solutions highlight the role of multidisciplinary interventions and technological innovations such as AI-based handwriting analysis for early detection and support. Future directions emphasise inclusive, culturally sensitive, and sustainable approaches to improve identification, intervention, and outcomes for individuals with dysgraphia.

Keywords: Dysgraphia; Specific learning disorder; Handwriting difficulties; Occupational therapy

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1.0 Introduction

Dysgraphia is a subtype of specific learning disorder (SLD) that impacts a person's ability to produce written language or handwriting skills, according to the American Psychiatric Association (2022). This condition causes difficulty with the action of writing, including fine motor skills, letter formation, and overall legibility. Difficulties in this area can significantly impact academic performance, self-esteem, and long-term educational outcomes, as handwriting remains a foundational skill in early education (Feder & Majnemer, 2007). Though widely acclaimed in diagnostic manuals such as the DSM-5-TR under SLD (with impairment in written expression), dysgraphia is usually

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under-identified, especially in mainstream school settings. The need for increased awareness, standardised assessment tools, and early intervention strategies is crucial (Asselborn et al., 2018).

There is limited data on the prevalence of dysgraphia in Malaysia and globally, with most studies focusing on small samples or related learning disabilities. No large-scale epidemiological studies provide definitive prevalence rates. Recent Malaysian research highlights the presence of dysgraphia using handwriting samples and machine learning for detection, but does not estimate national prevalence. Globally, studies often focus on broader learning disabilities, making it difficult to isolate dysgraphia-specific rates. This paper aims to explore dysgraphia's clinical features, detection methods, challenges, and future directions, particularly in Malaysia, while examining detection practices, challenges, and emerging interventions.

2.0 Literature Review

2.1 Understanding the Clinical Features of Dysgraphia

Dysgraphia is a neurological disorder characterised by significant difficulties in writing, affecting handwriting, spelling, and the organisation of written text (American Psychiatric Association, 2022). Core clinical features include poor handwriting quality, inconsistent letter formation, and impaired writing fluency (Chung et al., 2020; Gargot et al., 2020). Usually, it is not related to intelligence or educational opportunity. Affected children commonly exhibit illegible or inconsistent writing, poor letter formation, irregular spacing, and alignment difficulties. These impairments are frequently exacerbated by motor coordination challenges, such as atypical pencil grip, slow or effortful writing, and rapid hand fatigue, all of which disrupt writing fluency.

Beyond motor issues, dysgraphia is often associated with persistent spelling and grammatical errors, including letter omissions, duplications, and disorganised written output, despite intact oral language abilities (ElFiky et al., 2022). Visual-spatial and memory difficulties are also prevalent, manifesting as problems recalling letter shapes, spatially organising written content, or processing visual information, which may be pronounced in children with high intellectual ability or developmental coordination disorder subtypes (ElFiky et al., 2022). Additionally, deficits in cognitive and executive functions, including planning, sequencing, and working memory, further hinder writing performance and underscore dysgraphia's association with broader neurodevelopmental conditions. Collectively, these characteristics highlight the complex nature of dysgraphia and underscore the necessity for comprehensive, multidisciplinary assessment and intervention approaches. A brief description of the clinical features of dysgraphia is displayed in Table 1.

Table 1: Clinical Features of Dysgraphia

Feature	Description
Poor handwriting quality	Illegible, inconsistent letter size/spacing
Motor coordination problems	Awkward grip, slow writing, hand fatigue
Spelling/grammar errors	Frequent misspellings, omitted/duplicated letters
Visual-spatial deficits	Difficulty copying shapes, misaligned text
Cognitive/executive dysfunction	Trouble organising ideas, planning written output

Current research categorises dysgraphia into five distinct subtypes, each characterised by specific features that influence writing performance. Symptoms can emerge as early as 2–4 years of age, during critical stages of childhood development, and often exert a significant impact on learning and academic progress (Rocha Cabrero & De Jesus, 2022). The severity and presentation of these symptoms vary according to the underlying nature of the condition and the subtype involved. These are the five subtypes of dysgraphia.

The first subtype is dyslexic dysgraphia. Dyslexic dysgraphia is marked by illegible handwriting, frequent spelling errors, and a noticeable contrast between poor spontaneous writing and relatively clear copied work (Mohamed et al., 2020). Individuals with this subtype often struggle to generate legible written output independently, even though their fine motor abilities remain intact. In such cases, text that is copied from another source or drawings reproduced from a model are typically more accurate and organised. Importantly, the presence of dyslexic dysgraphia does not necessarily indicate a diagnosis of dyslexia. For example, a student with this condition may produce an essay that is messy and barely readable when written freely, but demonstrate neat and accurate handwriting when transcribing from a typed text.

The second subtype of dysgraphia is motor dysgraphia. Motor dysgraphia is associated with deficits in fine motor control, reduced dexterity, low muscle tone, and general motor clumsiness (Ariyo, 2024). Individuals with this subtype may produce legible letters in brief writing tasks, yet their overall handwriting and drawings are either spontaneous or copied. In addition, they tend to be poorly formed and often illegible. Despite these motor difficulties, their spelling skills are usually preserved. For instance, a person with motor dysgraphia may understand spelling rules but struggle to produce neat and readable handwriting due to weak muscle coordination and control.

The third dysgraphia subtype is spatial dysgraphia. Spatial dysgraphia arises from impairments in spatial awareness, which interfere with a student's ability to manage spacing between letters and maintain alignment within writing lines (Hamdioui & Vaivre-Douret, 2021). As a result, both handwriting and drawings are often consistently illegible, even though spelling abilities remain unaffected. For example, a student with spatial dysgraphia may produce text with unevenly sized and poorly spaced letters that drift above or below the writing line, making the overall work difficult to read.

The fourth subtype of dysgraphia is phonological dysgraphia. Phonological dysgraphia is marked by challenges in writing and spelling unfamiliar words, non-words, and words with irregular phonetic patterns (Rapcsak et al., 2009). People with this condition often find it hard to memorise individual sounds (phonemes) and to combine them accurately to form the correct spelling of a word. For

instance, someone with phonological dysgraphia may struggle to spell words like “knight” or “yacht” due to difficulty recalling the sounds and corresponding letter arrangements.

The fifth subtype of dysgraphia is lexical dysgraphia. Lexical dysgraphia is categorised when an individual can spell words but depends greatly on phonetic-to-letter conversions when writing, resulting in errors with irregular words (Friedmann & Gvion, 2023). This form is less common in children and is more frequently observed in languages such as English and French, which have less consistent spelling rules. Someone with lexical dysgraphia may regularly misspell words like “enough” or “Wednesday” because they rely on sounds rather than memorised spellings.

3.0 Methodology

This narrative review aims to explore the understanding, current detection, challenges, and future scope of dysgraphia, a specific learning disorder affecting handwriting and written expression. The review focuses on studies related to the clinical features of dysgraphia, detection methods, challenges faced by affected individuals, and emerging interventions, with particular attention to practices in Malaysia.

3.1 Literature Search and Selection Criteria

A comprehensive search will be conducted using databases like PubMed, ScienceDirect, and Google Scholar. Keywords such as "dysgraphia," "specific learning disorder," and "AI in dysgraphia detection" will guide the search. Inclusion criteria will focus on studies that directly address dysgraphia, its detection, and interventions, while excluding studies on unrelated learning disabilities or those with poor methodological quality.

3.2 Data Extraction and Organisation

Key details from selected studies will be extracted, including study objectives, methods, sample sizes, and findings. The studies will be organised into themes such as "clinical features," "detection methods," "challenges," and "interventions."

3.3 Critical Appraisal

Each study’s quality will be assessed based on its design, sample size, and methodology. The review will identify strengths, such as the use of standardised diagnostic tools, and weaknesses, such as small sample sizes or lack of control groups.

3.4 Synthesis and Interpretation

The findings will be synthesised qualitatively, identifying common trends and contradictions in the literature. The review will integrate these insights into a cohesive narrative, discussing how different studies contribute to understanding dysgraphia and its management.

3.5 Thematic Analysis and Conceptualisation

The results will be organised into broader themes, and a conceptual framework will be developed to illustrate the relationships between dysgraphia’s clinical features, detection methods, and challenges. This framework will guide future research directions and intervention strategies.

4.0 Findings

4.1 Current Detection in Malaysia

In Malaysia, detection of handwriting difficulties related to dysgraphia by health professionals typically involves a comprehensive, multidisciplinary approach. Clinicians such as paediatricians, psychologists, and occupational therapists utilise a combination of clinical observations, interviews with parents and teachers, and standardised assessment tools to evaluate a child's handwriting skills. Current assessments include Shore Handwriting Screening, the Developmental Test of Visual Perception (DTVP) and the Beery Visual-Motor Integration (VMI) to assess visual-motor coordination, as well as specific handwriting evaluation tools like the Evaluation Tool of Children's Handwriting (ETCH), the Print Tool, which examines legibility, form, spacing, and overall quality. Occupational therapists may also conduct fine motor and sensory-motor evaluations to identify underlying issues affecting handwriting development.

In order to identify problems of handwriting difficulty, handwriting sample analysis will be conducted. Malaysian studies commonly use structured handwriting tasks, where children are asked to copy or write specific sentences. These samples are then analysed for features such as irregular spacing, inconsistent letter shapes, uneven line alignment, and fluctuating letter sizes (Ramlan et al., 2024; Vydeki et al., 2024).

Additionally, collaboration with educators helps provide context regarding the child's academic performance and classroom behaviour. While Malaysia may not have a nationally standardised assessment specific to dysgraphia, professionals often refer to international diagnostic criteria, such as those outlined in the DSM-5, and adapt existing tools to the local context. Overall, a multidisciplinary approach combining observational, clinical, and educational data is essential for accurate diagnosis and intervention planning.

Another method of detection of handwriting difficulties is collaboration with Malaysia Dyslexia Association, which is also known as *Persatuan Dyslexia Malaysia* (PDM). They have their own method of assessment to classify the severity of dysgraphia. PDM’s

assessment approach begins with the collection of handwriting samples from children suspected of having dysgraphia, where they are asked to copy and write specific sentences in Malay, typically three sets, on paper forms (Ramlan et al., 2024). These samples are then digitised through scanning and converted into digital images, followed by preprocessing techniques such as binarisation and foreground/background adjustments to enhance clarity. Once processed, the handwriting is categorised into groups such as "potential dysgraphia" and "low potential dysgraphia," based on key visual indicators including irregular letter formation, inconsistent spacing, and misalignment on the page.

4.2 Challenges for Individuals with Dysgraphia

Individuals with dysgraphia face a complex set of challenges that extend beyond handwriting difficulties and influence multiple aspects of daily functioning. These challenges can be broadly categorised into four interrelated domains. First, academic and cognitive barriers hinder written expression, learning, and performance in school settings. Second, emotional, social, and behavioural impacts emerge as students struggle with frustration, anxiety, and peer comparisons, often affecting self-esteem and motivation. Third, systemic and environmental obstacles, including limited awareness among educators and insufficient classroom accommodations, restrict effective support. Finally, technological and diagnostic gaps, such as the lack of accessible tools and standardised assessments, further complicate early identification and intervention. Together, these domains highlight the multidimensional nature of dysgraphia and underscore the need for comprehensive strategies to address its wide-ranging impacts. A brief description of challenges for individuals with dysgraphia is illustrated in Table 2.

Table 2: Challenges for individuals with dysgraphia

Challenge	Description
Academic and cognitive barriers	Hinder written expression, learning, and performance
Emotional, social, and behavioural impacts	Frustration, anxiety, and peer comparisons
Systemic and environmental obstacles	Limited awareness among educators and insufficient classroom accommodations
Technological and diagnostic gaps	Lack of accessible tools and standardised assessments

Academic and cognitive barriers in dysgraphia manifest through multiple interrelated challenges. Students often struggle with handwriting difficulties such as illegible script, inconsistent letter formation, poor spacing, and reduced writing speed, which hinder effective note-taking, test performance, and completion of written assignments (Sasidharan & Kotian, 2025). These difficulties are frequently accompanied by spelling and composition issues, including grammatical errors, disorganised ideas, and poorly structured written output, resulting in incomplete or low-quality work. Additionally, deficits in orthographic long-term memory, working memory, and fine motor planning further complicate writing tasks, making it difficult for affected students to process, recall, and execute written language efficiently. Such challenges not only compromise academic achievement but also place additional cognitive load on students, leaving them with less mental energy for higher-order thinking tasks. Over time, these persistent struggles may lead to avoidance of writing activities, reduced participation in classroom tasks, and gaps in overall learning. Without timely intervention, academic and cognitive barriers can accumulate, creating long-term obstacles to educational progress and future opportunities.

Emotional, social, and behavioural impacts of dysgraphia are profound and often extend beyond the classroom (Saifudin et al., 2024). Continuous struggles with writing frequently generate frustration, anxiety, and diminished self-confidence, leading many students to avoid tasks that highlight their difficulties. Over time, these emotional burdens may foster feelings of inadequacy and disengagement from learning. Socially, challenges in written communication can limit opportunities for collaboration, making it harder for students to participate fully in group activities or maintain positive peer relationships (Sasidharan & Kotian, 2025). In some cases, these difficulties may contribute to social withdrawal or exclusion, further intensifying emotional distress. Together, these impacts highlight how dysgraphia not only affects academic performance but also shapes students' sense of belonging, motivation, and overall well-being.

Systemic and environmental obstacles play a significant role in shaping the experiences of students with dysgraphia. Many teachers face limitations due to insufficient training, lack of resources, and the absence of standardised assessment tools, making it difficult to accurately identify and support affected students, particularly in under-resourced or rural schools (Chaka et al., 2024). These gaps often result in delayed interventions and inconsistent support across educational settings. Furthermore, traditional remedial approaches, while beneficial to some extent, are frequently inadequate in addressing the multifaceted needs of students with dysgraphia. There is a pressing need for more holistic, technology-integrated, and culturally sensitive strategies that recognise diverse learning contexts and provide sustainable solutions. Without such systemic improvements, students may continue to face barriers that hinder their academic growth and equitable participation in education (Sasidharan & Kotian, 2025).

Technological and diagnostic gaps remain critical challenges in addressing dysgraphia effectively. Although AI-driven solutions and digital tools hold significant potential for supporting handwriting development and early detection, access to such technologies is often limited, particularly in under-resourced contexts, and their cultural adaptability remains underdeveloped (Akpan et al., 2025). These constraints reduce the scalability and inclusivity of technological interventions. At the same time, underdiagnosis and misidentification persist due to limited awareness among educators and healthcare professionals, as well as the absence of universally standardised diagnostic criteria. Such gaps are especially evident in adults, who may have remained undiagnosed throughout childhood, and in populations using non-Latin scripts, where assessment tools are scarce. Together, these limitations delay timely intervention and prevent many individuals from receiving the tailored support necessary to overcome the challenges associated with dysgraphia.

5.0 Discussion

5.1 Future Scope for Dysgraphia

Research on dysgraphia is growing rapidly, reflecting increasing recognition of its complex and multidimensional nature. Current trends emphasise technological innovations, such as AI-based diagnostic tools and assistive applications, which hold promise for improving assessment accuracy and enhancing learning support. At the same time, scholars are seeking deeper insights into the neurological, cognitive, and motor mechanisms underlying dysgraphia to better inform targeted interventions. Another critical direction is the development of inclusive and individualised approaches that account for cultural, linguistic, and contextual differences among learners. Future studies are also likely to explore long-term outcomes of intervention strategies, as well as the integration of multidisciplinary support systems within educational and clinical settings. Collectively, these directions highlight a shift toward more comprehensive and sustainable solutions for individuals with dysgraphia.

Technological advancements are increasingly transforming the way dysgraphia is identified and managed. A notable shift is occurring toward the use of digital tools, machine learning, and artificial intelligence for early detection, diagnosis, and intervention (Drotár & Dobeš, 2020). Automated handwriting analysis through tablets and advanced algorithms such as Convolutional Neural Networks and Long Short-Term Memory (CNN-LSTM), Random Forest, and deep transfer learning is significantly improving the accuracy, scalability, and accessibility of dysgraphia screening (Dimauro et al., 2020). These innovations not only enable more objective and efficient assessment but also provide opportunities for personalised intervention tailored to each learner's unique needs. Moreover, the integration of such technologies into educational and clinical settings holds the potential to reduce diagnostic delays and expand access to support, particularly in under-resourced contexts. As these tools continue to evolve, they are likely to play a central role in bridging gaps between research, practice, and inclusive education for individuals with dysgraphia.

Holistic and multidisciplinary approaches are becoming central to the future of dysgraphia research and intervention. Increasingly, scholars emphasise the integration of cognitive, neurological, motor, psychological, and environmental perspectives to fully capture the complexity of the disorder (Döhla & Heim, 2016; McCloskey & Rapp, 2017). This includes investigating the neural pathways and memory mechanisms that contribute to writing difficulties, with the aim of informing more precise and neuro-targeted interventions. Such approaches also highlight the importance of addressing both the mechanical and emotional dimensions of dysgraphia, ensuring that interventions support not only handwriting skills but also self-esteem and motivation. By bringing together insights from neuroscience, psychology, education, and occupational therapy, researchers can design more comprehensive and sustainable strategies. Ultimately, this multidisciplinary focus paves the way for interventions that are both scientifically grounded and adaptable to diverse learning environments.

Personalised and inclusive interventions are increasingly highlighted as essential in addressing the diverse needs of individuals with dysgraphia. Future directions emphasise tailoring support to account for cultural, linguistic, and socioeconomic diversity, ensuring that interventions remain accessible and relevant across varied contexts (Döhla & Heim, 2016; Sasidharan & Kotian, 2025). Hybrid models that combine traditional handwriting training with technology-assisted methods and self-regulated learning strategies are gaining momentum, offering a balanced approach that enhances both engagement and effectiveness (Han & Wang, 2025). These models not only build foundational writing skills but also empower learners to take an active role in their progress through adaptive digital tools. By integrating personalisation and inclusivity, such interventions aim to close equity gaps and foster more sustainable improvements in academic performance and confidence. Ultimately, this direction underscores the importance of moving beyond one-size-fits-all solutions toward more flexible and context-sensitive approaches.

Expanding populations and lived experiences are becoming an important focus in dysgraphia research. While much of the existing work centred on children, there is a growing recognition of the need to include adults, many of whom remain undiagnosed or continue to face persistent challenges in education, employment, and daily life (Sasidharan & Kotian, 2025). Research is also increasingly incorporating the perspectives of individuals with dysgraphia, along with input from parents, carers, and educators, to capture a more holistic understanding of its impact (Kalenjuk et al., 2022). This shift not only enriches the evidence base but also ensures that interventions and policies are informed by the voices of those directly affected. By integrating lived experiences with scientific findings, future support systems can be designed to be more empathetic, responsive, and contextually relevant. Ultimately, such inclusivity paves the way for interventions that acknowledge the lifelong nature of dysgraphia and provide more equitable opportunities across the lifespan.

Limitation

This narrative review has several limitations. First, the study is based on a selection of English-language articles, potentially excluding relevant non-English research. The lack of standardized diagnostic tools for dysgraphia, particularly in diverse settings like Malaysia, limits the generalizability of findings. The review also focuses primarily on small-scale studies, which may not be representative of broader populations. Additionally, technological advancements, particularly AI, in diagnosing dysgraphia are underexplored in resource-limited contexts. Finally, the reliance on published literature introduces potential publication bias, as studies with significant findings are more likely to be included, potentially overlooking null results.

Conclusion

Dysgraphia remains an under-identified but highly impactful condition that extends beyond handwriting difficulties, affecting academic performance, emotional well-being, and long-term opportunities. This paper has highlighted the complex clinical features, current detection practices in Malaysia, and the multifaceted challenges faced by individuals with dysgraphia. While technological innovations such as AI-driven handwriting analysis and tablet-based assessments show promise in enhancing early identification and intervention, systemic, cultural, and diagnostic gaps continue to hinder equitable access to support. Addressing dysgraphia requires holistic and multidisciplinary approaches that integrate cognitive, neurological, motor, psychological, and environmental perspectives, while also ensuring interventions are inclusive, culturally relevant, and sustainable. Future research should expand to diverse populations, incorporate lived experiences, and strengthen collaboration across education, healthcare, and technology sectors. By advancing innovative yet inclusive strategies, stakeholders can work toward reducing barriers, empowering learners, and ensuring that individuals with dysgraphia are supported to reach their fullest potential.

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