

Recent Advances in Intervention for Improving Handwriting: A Narrative Review

Kaaynat Khan^{1*}, Dr Munish Kumar Kakkar², Dr. Surendra Kumar Meena³

¹*PhD scholar, Mahatma Gandhi Occupational Therapy College

²Professor and Head of the Department of Pediatrics, Mahatma Gandhi University of medical sciences and Technology

³Principal, Mahatma Gandhi Occupational Therapy College

***Corresponding author:** Kaaynat Khan

*PhD scholar, Mahatma Gandhi Occupational Therapy College Address; 10224, 3rd floor, West Gorakh Park, Near Welcome Police Station, Shahdara New Delhi 110032 Email id kaaynatkhn@gmail.com

Abstract

INTRODUCTION: Handwriting and related fine motor problems are primary reason for referral to occupational therapy, particularly in the school setting. Different types of intervention are been used to improve handwriting.

OBJECTIVES: The primary purpose of this literature review is to list out recent trends in the treatment approaches being used for children with handwriting.

METHOD: A broad search was undertaken to identify relevant studies for this review. PubMed, EBSCOhost (including Academic Search Premier), CINAHL Plus With Full Text, Education, ERIC, MEDLINE, PsycINFO, Social Sciences, SocINDEX with full text, and OTseeker were included if they were published between 2013 and 2023, written in English, involving human participants, and were related to intervention of handwriting skill acquisition.

RESULT: Occupational therapists employ a range of strategies during intervention, including therapeutic practice, sensorimotor techniques, and practice with iPad apps. Curriculum based Handwriting programs have found to be effective with Occupational Therapist Guided Remediation. The use of telehealth-delivered handwriting therapies can increase handwriting speed; however, more study is needed to evaluate whether this modality also enhances handwriting quality and spelling. Adaptive techniques are also used to improve handwriting. Collaboration with other professional and parents have also shown positive outcomes.

CONCLUSION: The support of parents, teachers and group in incorporating various techniques are crucial along with handwriting intervention. The role of technology is still emergent and requires more exploration in its role in improving handwriting.

Keywords: Curriculum, Dysgraphia, Telehealth

INTRODUCTION

Handwriting is the process of forming letters, figures, numbers, or other significant symbols purposefully onto a surface by using tools like a pen or pencil. Both legibility (readability) and speed are important parameters of handwriting, especially in a school setting. Factors such as shape, alignment, size, and the spacing between letters and words affect the legibility of handwriting. ^[1]

Literacy skills, learning to read and write, are the major focus of the first three years of mainstream education. Handwriting has been shown to relate to other language-related abilities such as reading, spelling, and the composition of text. ^[2,3] Studies showed problems in handwriting could create a barrier to accomplish spelling and composition of well-structured text ^[4,5,6,7] because both motor execution and the generation of ideas during writing require attention at one time ^[8] and this competition between two different systems can result in making errors or low performance. Therefore, it is important to learn handwriting to be able to use it as a tool for higher-order cognitive functions.

Apart from visual-motor coordination, motor planning, cognitive and perceptual skills, and accurate processing of tactile and kinaesthetic information have been indicated as prerequisites for handwriting skill acquisition. ^[9] Handwriting in typically developing children was found to develop quickly during grade one (age 6-7 y) and reach a plateau by grade two (age 7-8 y), and it becomes automatic, organized, and available as a tool to compose a text with further development in grade three (age 8-9y). ^[7]

From grades 3 to 6, writing performance becomes gradually faster, more fluent, and more efficient. In the following years, a handwriting pattern develops in a personalized way. The maturation of movement parameters in handwriting strongly correlates with age and depends on the complexity of task. ^[10]

It has been shown that straight writing movements are replaced by slightly more curved movements, probably corresponding with the natural curvature of stationary movements of the hand and fingers. ^[11]

The graphic motor patterns in handwriting are visually guided in the early stages of learning ^[12, 13] then they become more dependent on kinaesthetic feedback when visual and kinaesthetic senses are integrated. Finally, it becomes automatic (effortless and fast retrieval and production of legible letters without the need for attention) at early adolescence. ^[13]

The speed of handwriting, on the other hand, has been shown to have a more or less linear progression during primary

Studies in which the correlation between the legibility and speed of handwriting were examined have found only weak positive correlation^[14, 16] or no significant relation.^[15, 17] Weintraub and Graham, however, reported that an instruction to write neatly decreased the speed of handwriting.^[17]

Handwriting and related fine motor problems are a primary reason for referral to occupational therapy, particularly in the school setting.^[18, 19, 20] Handwriting performance has a far-reaching effect on a child's self-image, academic achievement, attitude and behavior. Furthermore, it is often judged and seen as a reflection of an individual's capabilities.^[21, 22] Handwriting is both a form of communication and a life skill as in note taking, message taking, writing examinations or completing application forms. Bonney^[23] describes handwriting as a functional activity which can affect an individual's satisfaction, creativity, productivity and academic achievement. She suggests that occupational therapists are well placed to make a substantial contribution to handwriting as a specific area of human performance. Handwriting can be viewed as an occupational performance for the school-aged child in that it is an expected skill necessary for functioning in a mainstream classroom environment. The identification of underlying components contributing to poor handwriting performance is critical to the selection of a treatment strategy (Stephens & Pratt, 1989), however the contribution of these components to handwriting performance is not well understood.^[23] The evaluation and remediation of handwriting difficulties therefore represents a challenge to occupational therapists. The occupational therapists unique role is to analyze handwriting difficulties in terms of underlying deficits in postural, motor, sensory integrative, sensorimotor, perceptual or behavioral elements which may be interfering with legible handwriting performance.^[24, 25] A variety of approaches to treating children with handwriting difficulties are outlined in the literature, ranging from motor learning, perceptual-motor, sensory integrative and cognitive-behavioural strategies. However, there is little consensus on the most effective treatment strategy.^[23] The primary purpose of this literature review is to list out recent trends in the treatment approaches being used for children with handwriting and related fine motor problems.

METHODS

A broad search was undertaken to identify relevant studies for this review. Databases and sites searched which included following databases: PubMed, EBSCOhost (including Academic Search Premier), CINAHL Full Text, Education Full Text, ERIC, MEDLINE, PsycINFO, Social Sciences Full Text, SocINDEX with full text, and OTseeker., for all the database key words involved combining handwriting with each of the following descriptors, curriculum, instruction, intervention, and occupational therapy treatment. Each item identified through electronic searching was read by the authors and if it looked promising, based on the abstract or title, it was obtained. The searches were further narrowed by the use of filters, including peer-reviewed journal articles, publication within the past 10 yr, and clinical trials.

Inclusion criteria

Both peer reviewed journal and conferences paper were included if they were published between 2013 and 2023, written in English, involving human participants, and were related to intervention of handwriting. Some of the internet search engines such as Google scholar were used to identify grey literature. Hand search strategies were also used to find some articles. The authors looked through each study title, abstract, and full text for any possible relevant studies that met the requirements for inclusion.

RESULTS

On searching the literature, 15,400 articles matched the search word criteria. 8420 articles were found to be related to this study. After removing for duplication, 674 articles were reviewed for relevance. 61 Articles was included in the study based on inclusion criteria. All the authors were involved at each stage of selection and elimination of studies.

DISCUSSION

The categories of the intervention can be divided into following categories

Handwriting Curriculums

Printing like a Pro! Developed by Ivonne Montgomery is a free cognitively-based printing program for the primary grades. It is evidence-based and designed for classroom use and for use with students who have printing/handwriting challenges. Using a developmental framework this program teaches letters from easiest to hardest to form. Self-talk, and self-reflection and evaluation are the Cognitive strategies used for neat printing. Legibility, form and letter size improves significantly in a teacher-taught printing club with occupational therapy support.^[26]

Size matters handwriting program is based on simple concepts such as letter formation, size and space and aims to improve legibility. The Size Matters Handwriting Program uses a systematic child-centred approach, explicit instructions, and motor learning origins, making it easy to embed within the school curriculum. It is cost effective, efficient, and measurable. Size Matters program have shown improved legibility, form, alignment, size, and spacing in kindergarten, first, and second grade when implemented either alone or in collaboration with teacher^[27, 28] Self-monitoring was found to have a significant part in helping them comprehend the principles of handwriting and develop proper spacing techniques when writing. for kindergarten students in special education and those who are at-risk showed considerably larger improvements

in handwriting legibility were seen with noticeable bigger improvements in the prereading abilities in terms of uppercase, lowercase, and letter sound recognition^[29] with no improvements in visual-motor integration skills.^[30]

Write Start handwriting program: Developed by Terri Holland, promotes writing fluency through cotaught classroom-embedded intervention. Handwriting taught to first-graders and second graders by teachers and occupational therapists featuring station instruction and tailored supports along with Small-group practice with regular feedback, promoted self-assessment, and supported peer modeling. Students in the Write Start program outperform those in the normal instruction group in terms of legibility and fluency. Those who had poor baseline legibility have shown gains, indicating that the program may help students who are at risk for having handwriting and writing issues.^[31, 32] The impacts of early literacy on intervention outcomes using a modified Write Start on handwriting fluency in Australian kindergarten have also shown improved handwriting.^[33]

Handwriting Without Tears is a developmentally and multisensory-based handwriting curriculum emphasizing stages of learning and play based instruction for printing and cursive writing, can be implemented in the classroom by teachers and occupational therapists. There is a preliminary proof that using the Handwriting Without Tears® curriculum in first-grade schools is successful in improving handwriting and skill perception of Grade 1.^[34, 35] In comparison to write start program, Handwriting without Tears intervention had shown improvements in handwriting legibility. A hybrid model integrating strategies from Handwriting without Tears and Write Start is suggested.^[36] Through a consultative approach with occupational therapy^[37] of Handwriting Without Tears® for printing instruction, handwriting skills can also be facilitated. Occupational therapists advisory role in helping general education instructors adopt handwriting curricula have shown positive results. Handwriting Without Tears® curriculum have shown its efficacy in four-year-old with development delay to print the correct size, form, and instrument to write his first name^[38] as well as In an ADHD student in the first grade, requiring further research on a broader scale.^[39]

Write Direction^[40] addresses letter formation through body movements, kinesthetic awareness, and visual-motor skills have shown a statistically greater improvement in handwriting skills, including approximation, line orientation, proportion, and directionality.

Fine Motor and Early Writing Pre-K curriculum^[41] is a Handwriting readiness program using station teaching with adapted writing tools, workbooks, and sensory activities have shown positive changes which were not statistically significant.

Explicit handwriting program^[42] consists of digital dexterity exercises, cursive writing and metacognitive task combined with discussion and handwriting practice leading to better quality and speed of handwriting which was more regular, with fewer ambiguous letters and fewer incorrect relative heights.

Peterson Directed Handwriting curriculum uses movement sequence and rhythm to develop movement patterns for writing automaticity using the “we write to read” method. It was found to be as effective as Handwriting without Tears program in improving handwriting skills.^[43]

Teaching handwriting produced statistically higher levels of fluency and legibility, when contrasted with neither instruction of non-handwriting instructional situations. Although handwriting abilities were not improved by motor instruction but can be improved by individualizing handwriting training and teaching handwriting through technology.^[44] The needs of the children in the classroom would determine which curriculum should be used in classrooms for which the primary goal is legibility but not speed, size matters handwriting program will be best. Alternatively, the intensive handwriting program Write Start or the explicit handwriting program, might be best suited for classrooms for which the primary goal is handwriting speed,^[45]

Occupational Therapy Based Intervention

The occupational therapy services provided in schools showed improvement in legibility, in-hand manipulation, position in space, and letter readability; however, the effects of the intervention on speed and number legibility were inconclusive.

^[6] According to Kadar M^[46] occupational therapy interventions for preschoolers' handwriting abilities resulted in enhanced handwriting abilities independent of their medical issues. Occupational performance was optimized in a preschool context using an organized handwriting program combined with continuous coaching and collaboration.^[47] Handwriting and visual-perceptual skills were found to get better by occupation-based therapies while Perceptual-motor skill gains are stronger after handwriting therapies.^[48] For handwriting therapies, direct task-based learning is regarded as best practice; however, there are few studies at higher evidence levels that assess this strategy for pre-printing intervention.^[49] On the positive side, the pre-writing therapies for children with developmental difficulties and normally developing children were found to be in line with the handwriting prerequisites^[50] and females show increased abilities over time more than male peers.^[51]

In children with motor coordination problems several kinds of occupational therapy interventions such as Visual, motor, perceptual, sensory, activity of daily living skills, training device and assistive technology, and specialized handwriting programs improved handwriting performance.^[52] Interventions that employed occupation as a medium and encouraged self-management were most successful interventions for kids with Specific learning disability.^[53] However, the results of handwriting therapies cannot be generalized in children with other disabilities.^[54]

Alhusaini^[55] reported substantial improvement in readability, form, alignment, size, and spacing through use of sensorimotor intervention. Additionally, there were notable alterations in grip strength, legibility, and time performance. According to Fajariani^[56] Occupational therapists observed that kids struggling with Arabic characters benefitted from a

sensorimotor intervention that strengthens handwriting performance components and offers occupation-based graded activities. A strong relationship between handwriting legibility and speed and fine motor skills is seen.^[57] Exercising fine motor skills have shown improved students' English handwriting.^[58]

Hasenauer^[59] stated that the most successful programs were those that were rigorous, repeated, structured, and created or carried out by occupational therapists. To treat generalized handwriting impairment, repetitive task practice along with Mental Practice may be a useful therapeutic intervention.^[60] According to study by Denton, Cope, & Moser,^[61] sensorimotor intervention improved sensorimotor components whereas Therapeutic practice was more effective at improving handwriting performance.

Weintraub, Yinon, Hirsch, & Parush,^[62] reported that programs that include instruction in “higher-level” strategies to support and enhance handwriting performance are effective irrespective of whether the approach is sensorimotor or task oriented. For early writers, an occupational therapy handwriting program that combined cognitive strategy training pertaining to planning, memory, attention, and sensory perception along with writing instruction were found to have the biggest effects on learning and applying accurate alphabet-letter writing skills than in-class instruction alone.^[63] Also interventions based on motor learning theory and cognitive learning procedures are found to be successful in enhancing legibility.^[64] Banks, Rodger, & Polatajko,^[65] in their study discussed specific strategies of cognitive orientation to occupational performance used by children with Developmental coordination disorder while addressing handwriting goals. Discussion was the predominant tool employed to improve performance. Significantly, the children most often used strategies that increased their awareness and understanding of task requirements.

Visual Perceptual training have shown positive impact on developing scanning abilities, motor-free visual perceptual abilities, and handwriting speed and readability.^[66] In a study by Jameel HT^[67] Urdu handwriting readability along with abilities in Recognition, Alignment, Readability, Line, Size, Margin, and Similarity improved after Visual Perception training. Similar results were seen in study by Chang,^[68] in which haptic and visual perception training led to differences in far-point copy speed and handwriting accuracy in Chinese handwriting in addition to increased visual-perceptual skills. In children with developmental coordination disorders Training in visual motor integration have also shown promising results in developing handwriting skills.^[69] As compared with intense handwriting practice which improves handwriting legibility, visual-perceptual-motor activities have not shown discernible differences in handwriting speed or visual-motor abilities.^[70]

Technology Based Intervention

To address handwriting legibility, occupational therapists employ a range of strategies during intervention, including therapeutic practice, sensorimotor techniques, and practice with iPad apps. Comparing the efficacy of handwriting practice on iPad apps alone, handwriting practice using iPads in conjunction with a traditional OT multisensory approach, or a traditional OT multisensory approach alone with handwriting practice to improve handwriting legibility demonstrated noticeable improvements in letter in the former group.^[71] iPad apps are also used in children with autism for improving fine motor and visual-motor skills.^[72] In children diagnosed with a developmental disability generalization of the acquisition of letter writing from the iPod Touch® and stylus pen to paper and pencil was also found to be promising.^[73] Improvement in their handwriting legibility and speed in Children with dysgraphia by use of An iOS application namely dexteria in a tablet computer was reported enhancing the handwriting readiness and time taken for completing the activity concluding that the iPad-based training program focusing on visual motor skill training is effective.^[74] Children with dysgraphia have also shown improvements in near-point, far-point copy, dictation tests, and writing from phonetic symbols by using computer-assisted instruction system.^[75]

The use of telehealth as a form of care delivery has grown; particularly during the epidemic. Online learning did not adequately address handwriting, a task that pediatric occupational therapists are well-qualified to support with kids, families, and schools. The efficiency of delivering handwriting therapies via telehealth has not been studied despite rising usage. The efficacy and viability of the Handwriting Without Tears® (HWT) program for children who present with handwriting and/or spelling deficits when delivered via telehealth have shown increased pace of the handwriting without any changes in spelling and handwriting.^[76] However, telehealth devices' effects and technological problems were also noted. Telehealth-delivered handwriting therapies can increase handwriting speed; however, more study is needed to evaluate whether this modality also enhances handwriting quality and spelling. Similar results were seen by Laura Bray,^[77] showing improved legibility and speed; however the findings for spelling were equivocal.

Adaptations

Weighted pencils have found to be effective in enhancing the handwriting of special needs kids who were unable to form letters showing significant increase in their writing skills.^[78] Training with fidget spinners has also shown significant improvement in hand function, including handwriting legibility and grip strength in lower primary school kids' handwriting.^[79]

Collaborative Approaches

Some studies showed effectiveness of handwriting remediation when parent were involved. Through parent-coached home programs, an alternative service model as a means of facilitating access to research-based training handwriting abilities for underserved kindergarten pupils can be enhanced.^[80] Hybrid model of Orton-Gillingham and Handwriting without

Tears instructional programming for prewriting and handwriting skills in kindergarten students based on The Model of Human Occupation resulted in favorable teacher and student interactions with the occupational therapist as well as positive clinical outcomes for children. ^[81]

Handwriting Home programs have found to be effective with Occupational Therapist Guided Remediation. The efficacy of a parent-taught, occupational therapist-guided curriculum for handwriting training at home as a means of mastering the alphabetic letters and as a possible model for service delivery inside the school system has been found to be beneficial. ^[82]

According to Benning ^[83] Intensive summer handwriting camps have also shown improvement in manuscript and cursive skills and hence could enhance handwriting abilities.

CONCLUSION

Multiple strategies have been used to improve handwriting; among which the curriculum based handwriting program and occupational therapy interventions have been more prevalent. The support of parents, teachers and group in incorporating various techniques has shown a positive impact. The role of technology is still emergent and requires more exploration in its role in improving handwriting.

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