

EFFECTIVENESS OF A STRUCTURED OCCUPATIONAL THERAPY-BASED HANDWRITING INTERVENTION ON WRITING PERFORMANCE IN CHILDREN WITH ASD

Shumail Najam^{*1}, Zohaib Shahid²

^{*1}Student, Superior University Lahore

²Associate Professor, Superior University Lahore

^{*1}shumailnajam30.05.24@gmail.com, ²zohaib.rana@superior.edu.pk

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Corresponding Author: *

Shumail Najam

Abstract

Background: Autism Spectrum Disorder (ASD) is a complex neurodevelopmental disorder marked by the presence of social communication deficits, repetitive behaviors, and associated motor coordination and sensory impairments. ASD children often suffer from severe handwriting problems due to poor fine motor control, deficient visual-motor integration (VMI), and impaired motor planning and praxis abilities. Such problems affect their academic performance, class room involvement, and functional independence.

Objective: To investigate the effectiveness of a Structured Occupational Therapy (OT) handwriting intervention strategy in children with Autism Spectrum Disorder (ASD).

Methodology: Single-blind randomized controlled trial was conducted in Lahore, Pakistan involving 60 children with ASD (ages 7–12 years old). The participants were divided equally into 2 groups, Group A (conventional therapy, n=30) and Group B (structured 6–8 weeks OT Structured intervention strategy for 30–45 min, 3 days per week, n=30). The outcomes were measured through a standardized handwriting assessment and Canadian Occupational Performance Measure (COPM).

Results: Though both the groups were equal at baseline levels, the experimental group (Group B) demonstrated highly significant, clinically better outcomes after 8 weeks ($p < 0.001$). Handwriting scores increased significantly from 41.85 to 56.20 for the experimental group, while there was a small increment of 42.10 to 45.80 in the case of the control group. There was an excellent Time by Group interaction effect observed through mixed ANOVA ($\eta^2 = 0.46$). Performance on everyday functional activities (COPM) and parent satisfaction scores also achieved clinically significant improvements in the experimental group.

Conclusion: Task-oriented occupational therapy programs are far more effective than traditional therapy for enhancing both writing skills and functional capabilities of children with ASD.

Introduction

Handwriting is an important functional occupation among pediatric patients, acting as one of the major channels for cognitive encoding, written communication, and academic assessment within a school setting (1). Legible handwriting is dependent upon the functioning of various neurodevelopmental functions such as fine motor coordination, visual-motor integration, core control and sensory processing (2). If these basic skills are not adequately developed, significant difficulties will be encountered in terms of writing efficiency and legibility that can impact functional performance, academic frustration and academic self-efficacy among students (3).

Children who have been identified to have ASD have high prevalence rates for fine motor, dyspraxia, and sensorimotor problems in addition to core diagnostic criteria of social and communicative differences (4). Research findings indicate that more than 60% of children with autism demonstrate significant problems in handwriting, which include poor formation of letters, poor spacing, abnormal modulation of grip force, and rapid fatigue in hands. The motor-related writing difficulties typically hinder writing and performance in academics in spite of having intellectual strengths (5).

While accommodations like digital speech-to-text technology and extended time provisions mitigate current academic stressors, they fail to resolve the issues of poor motor-sensory coordination and inadequate kinesthetics inherent in handwriting impairment (4). Occupational therapy measures focusing on visual motor integration, fine motor skills, kinesthetic sensation, and sensory modulation have demonstrated some promise in ameliorating functional motor impairments (1). Nevertheless, there is still a lack of standardized occupational therapy approaches geared at addressing the unique sensory-perceptual abilities of ASD-affected children that need to be verified within a properly controlled trial (6).

In order to help fill the above clinical evidence gap, the study under consideration assesses the effects of a structured occupational therapy

approach to handwriting improvement in school-aged children with ASD. By testing for changes in standardized handwriting pre- and post-intervention parameters including legibility, spatial orientation, and writing speed, the study aims at providing empirical support for the implementation of occupational therapy interventions in clinical and educational practice. It is assumed that the children who are provided with the structured occupational therapy approach would demonstrate a statistically significant improvement in their handwriting performance.

Methodology

This randomized controlled trial involved a one-group pre-test post-test design aimed at assessing the effect of a structured writing intervention program through occupational therapy on children aged 7 to 12 years old with autism spectrum disorder (ASD) (7) based on DSM-5 classification criteria, with problems with handwriting, and having ability to understand simple oral instructions; those with severe mental retardation, uncorrected visual or auditory impairments (4), co-morbid neurological or musculoskeletal diseases, and previous intensive handwriting practice were not included in the study. The study was approved by the Institutional Review Board of Superior University, and the written informed consent was taken from the participants after determining the sample size of 54 subjects using OpenEpi (effect size = 0.8, alpha = 0.05, power = 0.80). The participants were selected through non-probabilistic sampling using purposive sampling method from the Comprehensive Rehabilitation Center (CRC) at Maryam Nawaz Autism Center, Lahore, and were randomly allocated (ratio 1:1) through computer generated random allocation sequence to either Control Group (n=30) who were provided standard occupational therapy which was unstructured, including general fine motor play and readiness activities for 30-45 minutes three times per week for 6-8 weeks or to Experimental Group (n=30) who were provided a structured 5-step occupational therapy

handwriting intervention program that included warm up/sensorimotor preparation of upper extremities, fine motor/hand manipulation skills, visual-motor integration skills, handwriting mechanics and sensory feedback techniques. The outcome assessors were blinded for the group allocation. The handwriting legibility and execution skills were assessed by standardized Handwriting Assessment (ICC = 0.85-0.95) and parents satisfaction was measured by Canadian Occupational Performance Measure (COPM; ICC = 0.80-0.89). Data Analysis was carried out using IBM SPSS Statistics Version 27.0; Normality was established through the use of the Shapiro-Wilk test ($P > 0.05$), enabling comparison of means between groups through the use of independent samples t-test and Chi-square test, comparison within groups over time through paired samples t-test, comparison of mean difference between groups after the intervention through independent samples t-test, and analysis of the effect of intervention over time through two-way repeated measures ANOVA (Group * Time) with a p-value of significance 0.05.

Results

The experiment involved 60 children diagnosed with ASD (9.55 ± 1.69 years; 65% male)

randomly assigned to an equal size Control Group ($n=30$), who received regular OT, and Experimental Group ($n=30$), which had undergone a 5-phase structured OT program aimed at improving handwriting skills. The Shapiro-Wilk test determined that the data was normally distributed ($p>0.05$), and the Independent Samples t-test and Chi-square analysis showed that there were no statistically significant differences in age ($t=0.17$, $p=0.860$), gender distribution ($\chi^2=0.07$, $p=0.791$), handwriting ($t=0.15$, $p=0.880$), COPM performance ($t=0.36$, $p=0.720$), and COPM satisfaction ($t=0.24$, $p=0.810$). At week 8 post intervention, the Independent Samples t-tests showed a statistically significant improvement in the experimental group handwriting score (56.20 ± 5.85 vs. 45.80 ± 5.95 ; $t=6.52$, $p<0.001$), COPM performance (6.90 ± 0.95 vs. 4.70 ± 1.10 ; $t=7.10$, $p<0.001$), and COPM satisfaction (7.05 ± 0.90 vs. 4.65 ± 1.08 ; $t=7.35$, $p<0.001$). Results from two-way repeated measures ANOVA showed that there were significant interaction effects between Time and Group on all main outcomes, namely: objective handwriting ability ($F=45.60$, $p<0.001$, $\eta^2=0.46$), COPM performance ($F=52.30$, $p<0.001$, $\eta^2=0.49$), and COPM satisfaction ($F=55.80$, $p<0.001$, $\eta^2=0.51$), suggesting that the systematic OT protocol was more effective.

Table 1: Handwriting Performance

Group	Baseline	4 Weeks	8 Weeks
Control	42.10 ± 6.15	44.20 ± 6.00	45.80 ± 5.95
Experimental	41.85 ± 6.40	50.75 ± 6.10	56.20 ± 5.85

Table 2: COPM Performance

Group	Baseline	4 Weeks	8 Weeks
Control	3.80 ± 1.05	4.30 ± 1.08	4.70 ± 1.10
Experimental	3.90 ± 1.02	5.80 ± 1.00	6.90 ± 0.95

Table 3: COPM Satisfaction

Group	Baseline	4 Weeks	8 Weeks
Control	3.75 ± 1.10	4.25 ± 1.12	4.65 ± 1.08
Experimental	3.82 ± 1.05	5.90 ± 1.00	7.05 ± 0.90

Table 4: Baseline Comparison (Independent Samples t-test)

Variable	t-value	p-value
Age	0.17	0.86
Handwriting	0.15	0.88
COPM Performance	0.36	0.72
COPM Satisfaction	0.24	0.81

Table 5: Post-Intervention Comparison (Independent Samples t-test)

Variable	t-value	p-value
Handwriting	6.52	<0.001
COPM Performance	7.10	<0.001
COPM Satisfaction	7.35	<0.001

Discussion

The key aim of the randomized control trial conducted in this research study was to assess the efficacy of a structured intervention for handwriting improvement among children with Autism Spectrum Disorder (ASD). Writing problems remain one of the most important but least attended barriers for the educational and psychological development of the specified group (8). Children with ASD usually need to invest too much cognitive effort in writing processes, such as forming letters and using the right tools, and this leaves little cognitive capacity for higher language functions (9). Statistical data of the conducted study indicate that a structured intervention during 6-8 weeks results in significantly better outcomes in all studied areas than traditional non-structured intervention (10). These considerable changes have been associated with the principles of neuroplasticity and structured motor learning (11). The experimental design did not involve repetitive practice but rather involved tasks with systematic training, feedback, multimodal cues, and strengthening of hands (12). With decomposition of the complex perceptual-motor activity of writing into simpler parts such as dexterity of fingers, tracing, spatial alignment among others, the procedure helped the children in developing automated motor patterns (13).

Such significant improvements in performance and satisfaction reflect successful transfer of learned skills into daily classroom and home environment activities. As the COPM tool relies

on semi-structured parent interviews, these changes in scores imply that the parents have noted tangible improvement in their children's ability to deal with writing tasks assigned at school without too much trouble (14). Specific problem areas identified during the therapy such as control of pencil grip strength and letter organization on the page addressed the daily issues that led to the development of anxiety and avoidance behavior in these children (15).

The positive results achieved through this trial match and expand on recent international studies concerning dysgraphia and neurodevelopmental approaches in children. The evidence obtained fully corroborates the results by Le Pong et al. (2025) whose randomized crossover study analyzed the influence of a spatially structured handwriting protocol in children with autism spectrum disorder (ASD) (10). Le Pong et al. (2025) reported the positive influence of structured geometrically-oriented protocols on children's writing legibility, fine motor skills, and visual-motor integration with high motivational levels achieved. Through the use of uniform session duration (30–45 min) and a consistent weekly schedule (3 sessions per week in 6-8 weeks), the current study supports the idea of the effectiveness of structured routines for children with ASD (10).

Moreover, the findings presented in this study support the conclusion made by Han and Wang (2025) after conducting their extensive analysis of developmental dysgraphia treatments and stating that task-specific, sensorimotor programs yield

better results than general therapy programs (16). Generic fine motor tasks, such as random coloring or playing with playdough, give general sensory feedback; however, there is no particular challenge in terms of spatial and movement planning necessary for correction of unique letter formation problems that arise from autism spectrum disorders (17). The current research also contributes to the literature reviewed by Zainol, Kadar, and Yunus (2022), which emphasizes the need for developing manualized, culturally-adapted handwriting guidelines (18).

It would be useful to examine our results in connection with the research carried out on larger samples of children. For example, Johnston et al. (2025) have carried out a pilot study of the pre-writing intervention on kindergarteners who do not demonstrate signs of atypical development and reported that although the children were progressing, general development and maturation over time have also been important (19). However, in the case of the clinical sample under consideration, the little progress made by the control group participants proves that children with ASD do not develop writing skills spontaneously and rarely outgrow difficulties related to handwriting (9).

The findings of this study have profound clinical and educational implications, especially within the context of healthcare in Pakistan. The pediatric rehabilitation services in Pakistan encounter various obstacles including resource limitations, lack of certified pediatric occupational therapists, and a lack of evidence-based protocols that are developed and implemented within local clinical settings. As a result, the majority of the children with developmental issues undergo generalized therapy that does not help address the particular problems of each child effectively (20). This study shows that even a short-term manual protocol (6-8 weeks) is enough to obtain significant clinical outcomes within the usual clinical setting. Hence, it may be considered that manualized protocols present an extremely efficient approach which may prove to be cost-effective.

Conclusion

In conclusion, this study proves that occupational therapy based writing intervention program is an effective way of enhancing writing abilities in children with autism spectrum disorder. The structure, which included fine motor skill strength training, visual-motor activities, and multisensory feedback proved to be better than the conventional methods. This research study will contribute to the practice of using manualized occupational therapy programs in Pakistan.

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