

EFFICACY OF GRIP STRENGTH AND HAND COORDINATION TRAINING IN IMPROVEMENT OF HANDWRITING IN SCHOOL CHILDREN

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ABSTRACT

Objectives: Proficient handwriting is critical for education and child's performance during academics. Students who struggle to acquire handwriting skills may experience frustration and anxiety, which in turn may negatively affect overall school performance. Studies of handwriting for typically developing children in Grades 1-5 have found the quality of handwriting develops quickly during grade one (ages 6-7 years typically) and reaches a plateau by grade two (age 7-8 years typically). It was found that grip force, i.e., grip strength and motor coordination is underlying mechanism for poor handwriting. There is little known about the effectiveness of physiotherapy treatment on the improvement of handwriting. Hence, the need arises to find out the "efficacy of grip strength and hand coordination training in the improvement of handwriting in school children." The purpose of the study is to evaluate the efficacy of grip strength training and hand coordination training in the improvement of handwriting.

Methods: This study is a randomized controlled trial of 30 school going children who were having handwriting problem diagnosed from Handwriting Proficiency Screening Questionnaire. Children are then randomly divided into 2 groups, Group A (experimental group) which consists of a grip strengthening and motor coordination exercises and Group B (Control Group) consists of ergonomics advice on handwriting and was taught appropriate writing posture by therapist and teachers. An activity of this group includes writing activities with different pencils, grasps, papers, etc. The handwriting quality was evaluated using Minnesota Handwriting Assessment.

Results: The results of this study showed that experimental group showed statistically significant results in improvement of handwriting.

Conclusion: It can be concluded that a well-planned physiotherapeutic program can help to improve the handwriting quality of school going children over a short period of time and thus help the child to improve his self-confidence and his academic results.

Keywords: Handwriting, Grip strengthening exercises, Motor coordination exercises, Handwriting proficiency screening questionnaire, Minnesota handwriting assessment tool.

INTRODUCTION

Proficient handwriting is critical for education and child's performance during academics. Handwriting is an important skill for school aged children who need to produce fluent and legible writing for expressing, communicating, and recording.[1].

Nowadays, handwriting is used as a predictor of one's personality. Students who struggle to acquire handwriting skills may experience frustration and anxiety, which in turn may negatively affect overall school performance. Children spend 31-60% of their school day performing handwriting and another fine motor task. Difficulty in this area can interfere with academic achievements [2].

Grip force means grip strength of an individual is understood to be the force exerted by the thumb and fingers on barrel of writing implement. The dynamic grasps with opposing positioning are deemed to be balanced grasps because the forces exerted by the three (or four). Digits intersect at a common point, and therefore, require minimal force to maintain. Grasps Also been categorized by the amount of hyperextension of the distal interphalangeal joint of the index finger as a proxy for grip force [3-5].

The production of functional handwriting depends on the complex interplay of a number of abilities, including skillful fine motor coordination and precise force regulation. Understandably, given the need for this complex integration of skill, learning to write can be challenging for children [6]. Fine motor skills become increasingly important when it is time for children to learn handwriting. Fine motor skills involve the use of the small muscles of the body that enable

movement and functions such as handwriting and grasping small objects [7].

Nowadays, various handwriting assessment tools are available. Judith E Riesman developed the Minnesota Handwriting Test (MHT) which has been used in this study. The interrater reliability of the MHT has a strong range of 0.87-0.98. The Minnesota Handwriting Assessment (MHA) is a popular and commonly used test with good psychometric properties and takes only a few minutes to administer [8].

Children who find handwriting difficult cannot always complete assignment on time may try to use as few words as possible, and most importantly, when focusing on the mechanical aspect of writing, cannot attend to cognitive content. Many studies had been done in occupational therapy for improving handwriting in children with providing a modified environment (pencils and pens of various widths, pencils and pens with different grips, pens or pencils that provide light as the student writes, weighted pens and pencils). Studies also had been done in this area combining occupational therapy with physiotherapy.

Less concentration has provided on the underlying cause of poor handwriting in typically developing children. Grip strength and motor coordination are found to be common components involved with the handwriting. So hence, effective solutions require creativity in service delivery and intervention options.

METHODS

A total of 300 Handwriting Proficiency Screening Questionnaires (HPSQs) were distributed in the Oxford English School, Bengaluru, in

the age group 5-8-year-old children. The questionnaires were filled by the teachers. A total of 30 children were selected to participate in this study with the aid of the standardized and validated HPSQ. Children who scored <14 on HPSQ questionnaire and fulfilled the inclusion criteria were randomly assigned to two groups. Simple random sampling was used to randomly allocate in Group A (n=15) and Group B (n=15).

Selection Criteria

Inclusion criteria

- School going children
- Age group 5-8 years
- Both gender.

Exclusion criteria

- Children with cognitive developmental disorder
- Dysgraphia
- Dyslexia
- Attention deficit hyperactivity disorder.

Procedure

The students selected by the teacher on the basis of the HPSQ who fulfilled the inclusion criteria were randomly assigned to two groups. Simple random sampling was used to randomly allocate 30 students in Group A and 30 students in Group B. Group A (intervention group): n=30 and Group B (control group): n=15.

Parents/guardians were provided with a description of the study, and informed consent forms were sent to them along with a family history to identify any known case of hereditary disease or any other major medical illness, so as to exclude from the study. After getting consents from the parents, children willing to participate in the study were asked to give assent, and the data were collected.

Pretest measurement was taken for both the groups using the pinch gauge, box and block test and MHA. The student sat on the desk and asked to copy the words utilized were a derivative of the sentence, "The quick brown fox jumped over the lazy dogs." The quality of the sample was determined by assessing legibility, form, spacing, alignment, and size.

After the pretest measurement students in Group A (interventional group) were given a set of grip strengthening and coordination exercises. The student's received 6 sessions of physiotherapy per week, for 30-45 minutes every day for 4 weeks. The students in the Group B (control group) received ergonomic advice on handwriting and were taught appropriate writing posture by therapist and teachers. After 4 weeks, again the postintervention measurements were taken for both the groups using pinch gauge, box and block test and MHA.

Group A (interventional group)

Strengthening exercises

1. Child manipulates clay, putty, dough and other resistance materials (finger hooks, full grip, finger extension, finger spread, finger scissor, finger pinch, scissor spread, thumb extension, thumb press, thumb adduction, thumb pinch strengthening, and three jaw chuck pinch ball) cutting these materials with scissors or a plastic knife also strengthens muscles
2. Place a rubber band around knuckles open and close hand/fingers
3. Ball squeezing exercise.

Coordination exercises

Coordination activities with box and block test consist of a wooden box 53.7 cm by 25.4 cm which is divided into two equal compartments by a 15.2 cm high partition. The subject will be instructed to transfer as many 2.5 cm cubes as possible from one compartment to the other in 1 minute. The subject's score is the number of cubes transferred in 1 minute.

Group B (control group)

1. Writing and drawing activities with pencils of various widths
2. Writing and drawing activities with pencils with different grips
3. Writing on special paper (broad and small lines)
4. Children will be directed with verbal cues.

Ergonomic advice on handwriting and were taught appropriate writing posture therapist and teachers.

RESULTS

In this study, Table 1 and Fig. 1a and b gender in both the groups are compared. They showed that both the groups are having males in more number than females. It is 11 and 9 of males in Groups A and B and 4 and 6 of female in both groups.

In Table 2 and Fig. 2, the age difference was compared in both the groups, and the mean age in both the groups was 7.53 in Group A and 7.6 in Group B.

In Table 3 and Fig. 3, the pre and postvalues of box and block test are compared of Group A. The mean and standard deviation (SD) of pretest were 30.6±5.77 and posttest were 43.46±8.15. t value of the same is 11.27 at p=0.000. This shows that there is a significant difference between the pre and postvalues of box and block test of Group A.

Table 1: Distribution of subjects by study groups and gender

Gender	Group A	Group B	Total
Male	11	9	20
Female	4	6	10
Total	15	15	30

Table 2: Mean and SD age of subjects by study groups

Summary	Group A	Group B
Age (mean±SD)	7.53±0.51	7.6±0.50

SD: Standard deviation

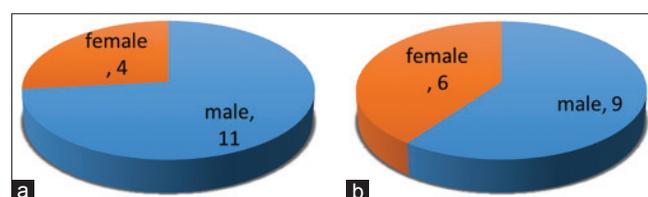


Fig. 1: (a) Distribution of subjects by in Group A. (b) Distribution of subjects by gender in Group B

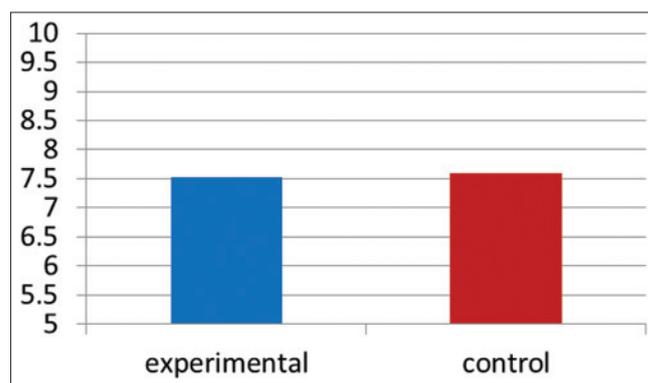


Fig. 2: Comparison of mean age of subjects by study groups

In Table 3 and Fig. 3, the pre and postvalues of grip strength are compared of Group A. The mean and SD of pretest were 3.56±0.75 and posttest were 4.98±0.85. t value of the same is 8.48 at p=0.000. This shows that there is a significant difference between the pre and postvalues of box and block test of Group A.

In Table 3 and Fig. 3, the pre and postvalues of MHA total are compared of Group A. The mean and SD of pretest were 122.86±20.23 and posttest were 147.73±11.04. t value of the same is 8.32 at p=0.000. This shows that there is a significant difference between the pre and postvalues of box and block test of Group A.

In Table 4 and Fig. 4, the pre and postvalues of box and block test are compared of Group B. The mean and SD of pretest were 32.06±5.29 and posttest were 33.6±5.20. t value of the same is 1.92 at p=0.075. This shows that there is no significant difference between the pre and postvalues of box and block test of Group B.

In Table 4 and Fig. 4, the pre and postvalues of grip strength are compared of Group B. The mean and SD of pretest were 3.76±0.47 and posttest were 3.95±0.50. t value of the same is 0.5364 at p=0.5959. This shows that there is no significant difference between the pre and postvalues of box and block test of Group B.

Table 3: Comparison of outcome measures in Group A by paired t-test

Outcome measures	Pre/post	Mean±SD	t value	p value
Box and block test	Pretest	30.6±5.77	11.27	0.000*
	Posttest	43.46±8.15		
Grip strength	Pretest	3.56±0.75	8.48	0.000*
	Posttest	4.98±0.855		
MHA total	Pretest	122.86±20.23	8.32	0.000*
	Posttest	147.73±11.04		
MHA subscales				
Legibility	Pretest	29.8±2.95	4.67	0.000*
	Posttest	32.33±1.67		
Form	Pretest	25.46±5.06	6.87	0.000*
	Posttest	28.8±4.021		
Alignment	Pretest	24.4±8.27	4.3	0.000*
	Posttest	29.4±4.35		
Size	Pretest	23.93±8.057	4.88	0.000*
	Posttest	30.13±3.37		
Space	Pretest	19.26±4.35	7.79	0.000*
	Posttest	27.06±4.21		

*p<0.05. SD: Standard deviation, MHA: Minnesota handwriting assessment

Table 4: Comparison of outcome measures in Group B by paired t-test

Outcome measures	Pre/post	Mean±SD	t value	p value
Box and block test	Pretest	32.06±5.29	1.92	0.075*
	Posttest	33.6±5.20		
Grip strength	Pretest	3.76±0.47	0.536	0.5959*
	Posttest	3.95±0.50		
Mha total	Pretest	118.73±29.14	6.013	0.000*
	Posttest	124.46±25.94		
Mha subscales				
Legibility	Pretest	29.4±4.43	2.824	0.014*
	Posttest	29.8±4.30		
Form	Pretest	23.93±5.84	2.46	0.027*
	Posttest	24.6±5.57		
Alignment	Pretest	22.2±9.11	3.62	0.003*
	Posttest	23.2±8.27		
Size	Pretest	24.06±9.33	3.416	0.004*
	Posttest	25.06±8.31		
Space	Pretest	19.13±5.70	6.925	0.000*
	Posttest	21.73±5.40		

*p<0.05. SD: Standard deviation

In Table 4 and Fig. 4, the pre and postvalues of MHA total are compared of Group B. The mean and SD of pretest were 118.73±29.14 and posttest were 124.46±25.94. t value of the same is 6.013 at p=0.000. This shows that there is a significant difference between the pre and postvalues of box and block test of group.

In Table 5 and Fig. 5, the posttest mean and SD of box and block test values of both Groups A and B are compared and the t=3.948 at p=0.000. This shows that there is a significant difference between posttest values of box and block test between the two groups.

In Table 5 and Fig. 5, the posttest mean and SD of grip strength values of both Groups A and B are compared and the t=4.003 at p=0.000. This shows that there is a significant difference between posttest values of grip strength between the two groups.

In Table 5 and Fig. 5, the posttest mean and SD of MHA values of both Groups A and B are compared and the t=3.196 at p=0.003. This shows that there is a significant difference between posttest values of MHA between the two groups.

DISCUSSION

This study was carried out to find out the efficacy of grip strength and hand coordination training in the improvement of handwriting in school children. In this study, it was observed that a 4 weeks grip strengthening training and coordination training had a significant effect on improving the handwriting quality, and the earlier studies also show the same result [9]. The positive results found in this study can be supported by the sufficient evidence in the literature that intervention to improve handwriting would result in greater gains than no intervention at all [10-13].

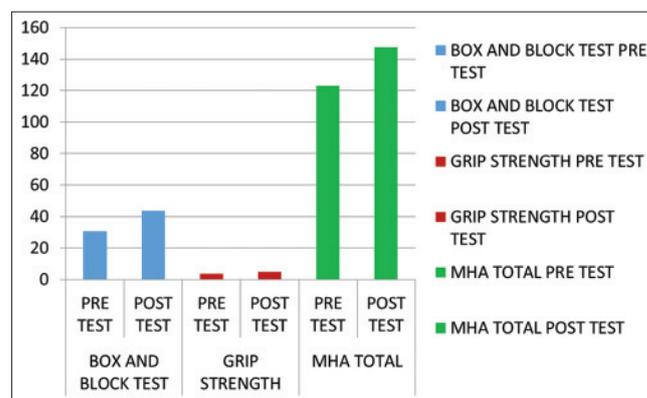


Fig. 3: Comparison of outcome measures in Group A by paired t-test

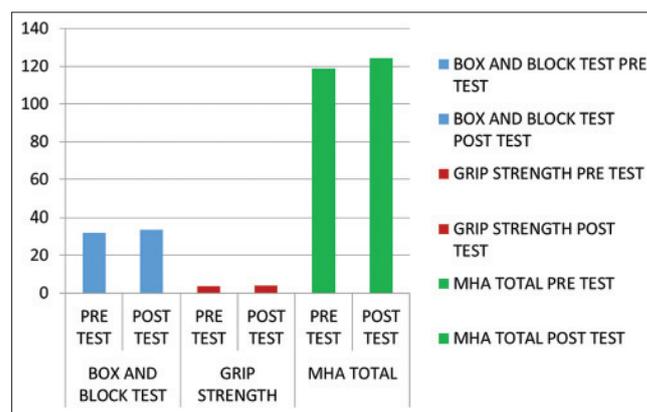


Fig. 4: Comparison of outcome measures in Group B by paired t-test

Table 5: Posttest comparison of Groups A and B with respect to outcome measures by unpaired t-test

Outcome measure	Group	Mean±SD	t value	p value
Box and block test	Group A	43.46±8.15	3.948	0.000*
	Group B	33.6±5.20		
Grip strength	Group A	4.98±0.85	4.003	0.000*
	Group B	3.95±0.50		
Mha total	Group A	147.73±11.04	3.196	0.003*
	Group B	124.46±25.94		
Mha subscale Legibility	Group A	32.33±1.67	2.067	0.048*
	Group B	29.8±4.30		
Form	Group A	28.8±4.02	2.366	0.025*
	Group B	24.6±5.57		
Alignment	Group A	29.4±4.35	2.568	0.16*
	Group B	23.2±8.27		
Size	Group A	30.13±3.37	2.185	0.037*
	Group B	25.06±8.31		
Space	Group A	27.06±4.21	3.013	0.005*
	Group B	21.73±5.40		

*p<0.05. SD: Standard deviation

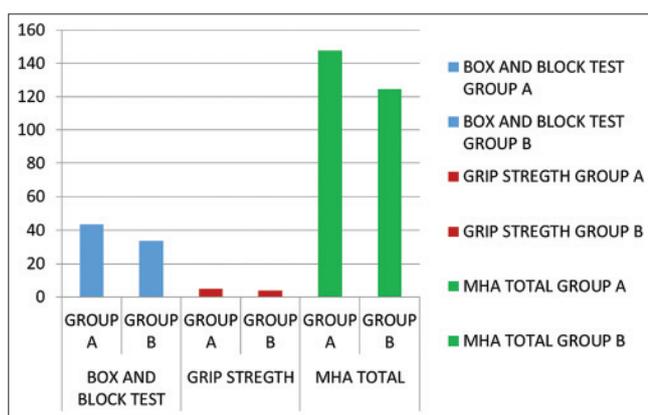


Fig. 5: Posttest comparison of Groups A and B with respect to outcome measures by unpaired t-test

The intervention was so planned that it directly targeted on the components which are required for good handwriting. The intervention consisted of exercises to improve grip strength and motor coordination. The intervention targeted primarily at the grip strength which is essential for the static and dynamic pencil grasp. An increase of tripod grip strength will prevent slipping of the pencil, which helps to improve handwriting and speed of writing. Thus, improves academics and confidence leading to decrease in depression and anxiety. This is supported by the study done by Falk *et al.* [14] in 2010 suggest that grip force dynamics play a key role in determining the handwriting quality.

Next the strengthening exercises which included activities such as manipulating clay, dough, or putty as to provide resistance to smaller muscles of hand, and ball squeezing exercises. All these exercises make use of the muscles of the thenar eminence which is considered as the “skilled triad” of the hand. Hence, the in-hand manipulation skills helped to improve the fine motor skills as well as grip strength [15-17].

Coordination exercise was given with the use of box and block test. Previous studies in this field have revealed that the production of functional handwriting depends on the complex interplay of a number of abilities, including skillful fine motor coordination, and precise force regulation [6]. Tom have, Van Heest did study in 2015 and stated that box and block test is reliable and valid tool for measurement and training of fine motor coordination as well as manual dexterity function [18].

The children in Group B were taught appropriate writing posture and were given ergonomic advice provided by the physiotherapist to their parents and teachers. The ergonomics and the writing posture are the extrinsic factors related to handwriting. Ergonomics [19-21] play an important role. Body posture is generally considered to have an important influence on the efficiency of writing process and product. Hence, students in Group B also showed improvement in their handwriting quality.

After a period of 4-week, both the groups showed an improvement in their handwriting quality but in comparison the students in Group A (experimental group) showed more significant improvement as compared to the students in Group B (control group). Finally, it can be concluded that a well-planned physiotherapeutic program can help to improve the handwriting quality of the children and help improve their academic results and confidence.

CONCLUSION

From the above study, it has obtained that there is a significant difference among the Groups A and B when the values were analyzed. There is a significant improvement in grip strength, coordination and MHA total score. Individual component of MHA that is legibility, form, alignment, size, and space is also shown significant improvement. Hence, it can be concluded that well-planned physiotherapy program can help to improve the handwriting quality of the children and help improve their academic results and confidence.

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