ORIGINAL RESEARCH PAPER
Volume - 10 | Issue - 09 | September - 2021 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ADDITIVE EFFECT OF FOUR WEEKS OF ROTATOR CUFF STRENGTHENING OVER FOREARM, WRIST AND HAND STRENGTHENING ON SPEED AND ENDURANCE OF WRITING IN PHYSIOTHERAPY STUDENTS: A PILOT STUDY

Physiotherapy

Maria Dalal* Intern At K.J. Somaiya College Of Physiotherapy. *Corresponding Author

Shweta Manwadkar Professor And Principal, K.J. Somaiya College Of Physiotherapy

ABSTRACT

Students struggle during long written examinations to complete the paper, experiencing fatigue and cramping sensations. Previous studies show that the strengthening of the upper limb improves writing speed (words in one minute), but no studies establish its effect on longer duration of writing. The authors conducted a four week strengthening protocol to understand the effect of additional rotator cuff strengthening over only forearm wrist and hand strengthening on the writing speed and endurance. Results show significant improvement in speed and endurance in both groups, but there is no additional effect of Rotator Cuff strengthening. Incorporation of an upper limb strengthening protocol before examination season can enhance students' performance.

KEYWORDS

handwriting speed, upper limb strengthening, examination, academic performance

INTRODUCTION

The act of writing is a complex coordination of gross, fine, and perceptual skills.[1] It has established its importance in the history of civilisation as a strong, long-lasting agent of growth and change. As the world moves increasingly towards digitised communication, the daily needs of handwriting have reduced. Letters, notes, and charts, even in the healthcare community, have moved to computerization. However, most academic examinations continue to be conducted in traditional pen-paper format. These long examinations require students to reproduce large amounts of information at a continuous stretch, without a break. Students complain of a decrease in speed of writing with fatigue as the paper progresses. They cannot complete their papers in the stipulated time leading to the affection of their academic performance.[2] The improper grip of the pen and mental stress of testing increases the pressure applied which leads to faster fatigue [3] When the student is unable to complete the paper, not only is their evaluation affected but so is their confidence.

Studies have been conducted to understand the effect of forearm, wrist, and hand strengthening, of grip strengthening, but no studies have been performed to understand the effect of the strengthening of shoulder stabilisers on writing speed and endurance. The activity of handwriting has been studied where maximum movements come from the forearm while the shoulder provides the power with minimum movement occurring at fingers and wrist.[4] It is known that the stability of the proximal shoulder girdle plays an important role in distal hand activity, and the activation of the rotator cuff muscles (Supraspinatus, Infraspinatus, Teres Minor, Subscapularis) is more significant than shoulder mover muscles during hand activity. [5,6] Aagaard et al concluded that strength training can lead to enhanced long-term (>30 min) as well as short-term (<15 min) endurance capacity. 7 It is theorised that training of the shoulder muscles will not only give a boost to the speed of transcribing over small periods but can also affect the speed and energy expenditure when writing for longer periods, as is the requirement in subjective examinations. This study hopes to understand the effect of strengthening Shoulder Stabilisers on a low-intensity, long duration gripping activity- like writing.

MATERIAL AND METHODOLOGY

We conducted an experimental study at the K.J. Somaiya College of Physiotherapy during a course of 6 months on physiotherapy undergraduate students.

***INCLUSION CRITERIA*:** Age 18-23 years, willing to participate, fluency in language of testing, writing speed > 15 words/minute

***EXCLUSION CRITERIA*:** Congenital/ Acquired structural or functional impairment of upper limb, Neuromuscular condition, learning disability, writing disability, uncorrected visual impairment, Individuals on an exercise regimen for upper limb, Pain in neck or upper limb at rest

***Sample size*:** 20: 10 per group

***Allocation to groups*:** Simple Random Sampling

***Materials required*:** Dumbbells, A4 sheet papers, uniform pens, Writing material provided to participants to copy from of same size and font in English language

***Outcome measures*:**

1. Handwriting Speed (HST): Words written in one minute
2. Handwriting Endurance (HE) : Words written in 30 minutes

STUDY PROCEDURE

Approval from Ethics Committee of K.J. Somaiya was obtained. Subjects were chosen on the basis of inclusion criteria, exclusion criteria and willingness to participate. Written format consent was taken from subjects after explaining the details of the study.

***Pre- Testing*:** Day 0 over Zoom meeting. Participants instructed to set a stopwatch for 30 minutes. 'Start writing from the text provided to you. At the end one minute mark a stroke to indicate how much you wrote in the first minute of the test. Stop writing exactly at the 30 minute mark. Words that can be read will be counted.' Participants were asked to send a scanned copy of their written test. Words written in first minute (HST) and Words written in 30 minutes were counted and recorded. Participants were allocated into the following groups using Simple Random Sampling.

***Group A*:** Rotator Cuff strengthening + Wrist + Forearm + Hand strengthening

***Group B*:** Wrist + Forearm + Hand strengthening

1. *For Rotator cuff strengthening:* 8,9:
A. Prone lying shoulder extension (inner range),
B. Shoulder Abduction 0-15 degree in Side lying, arm in adducted position, lateral rotation of arm till it is vertical, C. Medial rotation of shoulder against resistance

2. *For elbow and forearm* 10
A. Bicep curls, B. Elbow Extension with arm overhead, C. Supinators- Neutral shoulder by side of body, Elbow 90 flexion, D. Pronators- Neutral shoulder by side of body, Elbow 90 flexion

3. *For Wrist in - Neutral shoulder by side of body, Elbow 90 flexion* 11
A. Flexion. B. Extension, C. Radial deviation, D. Ulnar deviation

4. *For Pinch strengthening* 11
A. 3 jaw pinch hold 10 seconds x 10 reps
B. 3 jaw pinch strength: Opening 10 knots

Video demonstrating the above exercises were approved by the institutional research board (IRB) and sent via email to the subjects based on their group allocation.

Participants were asked to follow the exercises at home as

demonstrated to them on their video. The exercise volume to be followed was 10 repetitions / Exercise, 5 days / week

Post Study Testing: conducted 1 day after completion of strengthening programme over 4 weeks. The same instructions as pre-study testing were explained to the participants.

RESULTS AND ANALYSIS

Data was analysed using Graph Pad Instat software version 3.10. Paired and unpaired t tests were used within group and between groups respectively for comparing the variables. When data did not pass normality, Wilcoxon signed rank test was used within group and Mann Whitney test was used between groups.

Table 1: Comparative Analysis of Outcome measures post intervention in Group A and B

No. of words Pre-test		No. of words Post-test		p-value	Normality
M	*SD*	*M*	*SD*		
Group A HST- Significant					
24.80	2.78	28.9	3.03	0.002	No
Group B HST – Significant					
25.80	3.61	28.7	4.45	0.002	No
Group A HE – Significant					
605.1	46.84	660.20	57.21	0.002	No
Group B HE – Significant					
625.10	81.33	671.1	82.36	0.001	Yes
HST: Difference between 2 groups after Intervention- Not Significant					
4.10	2.03	2.9	2.13	0.125	No
HE: Difference between 2 groups after Intervention – Not Significant					
55.10	37.84	46.00	22.84	0.526	Yes

The study reveals statistically significant improvement in handwriting speed after intervention in Group A and Group B. (p= 0.0020). The study reveals statistically significant improvement in endurance after intervention in Group A and Group B. (p= 0.0020 and p=0.0001 respectively). The study shows statistically insignificant comparison in speed and endurance after intervention in Group A and Group B.

DISCUSSION

This study was conducted to assess the additive effect of four weeks of Rotator Cuff Strengthening over Forearm, Wrist, and Hand Strengthening on speed and endurance of writing in Physiotherapy Students.

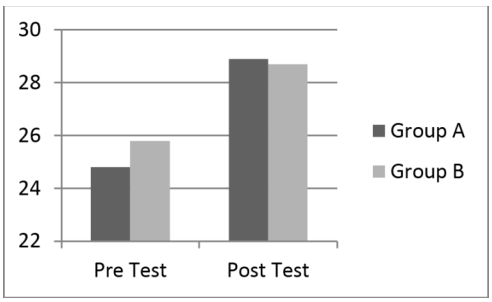

Figure 1: Comparison of Handwriting Speed Means between Group A and B (words in one min)

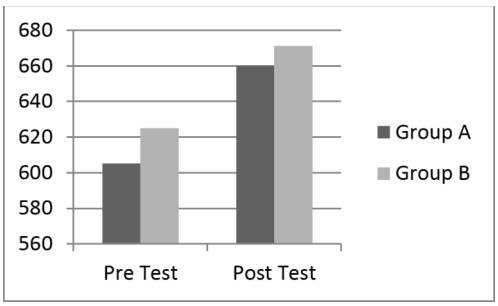

Figure 2: Comparison of Handwriting Endurance Means between Groups A and B (words in 30 mins)

Undergraduates need to transcribe large amounts of information in their university examinations. The handwriting must be legible and completed within a stipulated time limit under a lot of mental pressure.[12] many students feel cramping sensations, fatigue, and a considerable decrease in handwriting speed as the exam progresses. There is a lack of defined protocol to increase the endurance of writing, most studies focus only on speed.

The study reveals statistically significant improvement in handwriting speed after intervention in Group A and Group B. (Figure 1) Upper Limb strength greatly controls the coordination of gross and fine motor skills. Hand grip conjointly increases the activity of shoulder, biceps and forearm muscles.5 This is corroborated by Nilukshika KVK et al., (2012) who concluded that "Upper limb exercise programmes can be used to improve the handwriting speed" [13]

The study reveals a statistically significant improvement in endurance after intervention in Group A and Group B. (Figure 2) Strength coaching leads to increase in muscle cross-sectional area, motor unit efficiency and improved force production by muscle.[14] Locally, the increase of mitochondrial and capillary density enhances the muscle's ability to obtain oxygen and use it. This delays the onset of fatigue when performing a prolonged activity.[15]

This has not been tested before and is a finding that establishes that strengthening of the upper limb can have an improvement in the writing of longer duration, which was not seen when the effect of the intervention was only seen on the writing speed, in a short burst of activity. Handwriting Speed Test: (number of words written in a single minute) was the only outcome measure recorded by Kamalanathan et al. in the study of the effect of upper limb strengthening on handwriting.[16] If a sustainable protocol to improve endurance could be incorporated before exam season, students will be able to write more content within the same time.[17]

This study provides evidence that strengthening can show improvement in longer periods of continuous writing. This has the clinical implication to encourage Upper limb strengthening for an effective improvement in the months before long-form examination.

The study shows a statistically insignificant comparison in speed and endurance after intervention in Group A and Group B. This conveys that Rotator cuff strengthening does not significantly affect forearm wrist and hand strengthening on the improvement of writing speed or endurance.

CONCLUSION

The strengthening of the Upper Limb in a sustainable short exercise protocol that can be incorporated into a student's daily routine significantly improves the performance in a written examination. The study shows a noteworthy increase in both writing speed and endurance post-intervention. However, there is no additive effect of the rotator cuff strengthening over the forearm, wrist, and hand strengthening on our outcome measures between the two groups.

LIMITATIONS AND SUGGESTIONS

A limitation of this study notes that instruction of exercises to be performed was given to the participants via video, in place of in-person demonstration. Suggestions for further studies can be a larger sample size. Studies can be performed with students from different disciplines who require specific postures and fine motor skills: like technical drawing, architecture, and engineering.

REFERENCES

1. Erhardt, Rhoda & Meade, Vickie. (2005). Improving handwriting without teaching handwriting: The consultative clinical reasoning process. Australian Occupational Therapy Journal. 52. 199 - 210. 10.1111/j.1440-1630.2005.00505.x.
2. Ziviani, J. Some elaborations on handwriting speed in 7- to 14-years old: Perceptions and. Motor Skills.1984;58(2): 535-539.
3. Tseng, Mei Hui. "Development of Pencil Grip Position in Preschool Children." The Occupational Therapy Journal of Research, vol. 18, no. 4, Oct. 1998, pp. 207–224, doi:10.1177/153944929801800406.
4. Kao HSR: The effect of hand-finger exercise on human handwriting performance. Ergonomics 1973; 16:171-175
5. Alizadehkhaiyat.O, Fisher. A.C, Kemp. G.J, KarthikVishwanathan, S.P. Frostick. Shoulder muscle activation and fatigue during a controlled forceful hand grip task. Journal of Electromyography and Kinesiology (2011) 21 , 478–482.
6. Sporrong H. Hand grip increases shoulder muscle activity An EMG analysis with static hand contractions in 9 subjects. AcfaOrthopScand 1996; 67 (5): 485-490
7. Effects of strength training on endurance capacity in top-level endurance athletes *P. Aagaard , J. L. Andersen,* Scand J Med Sci Sports 2010: 20 (Suppl. 2): 39–47 A/S doi: 10.1111/j.1600- 0838.2010.01197.x
8. Edwards P, Ebert J, Joss B, Bhabra G, Ackland T, Wang A. EXERCISE REHABILITATION IN THE NON-OPERATIVE MANAGEMENT OF ROTATOR CUFF TEARS: A REVIEW OF THE LITERATURE. *Int J Sports Phys Ther*. 2016; 11(2): 279–301.

9. Kisner C, Colby L, Borstad J. Therapeutic Exercise Foundations and Techniques. 6th ed. Philadelphia: Jaypee Brothers Medical Publishers, 2012. Chapter 17: The Shoulder and Shoulder Girdle; p. 596-610.
10. Kisner C, Colby L. Therapeutic Exercise Foundations and Techniques. 6th ed. Philadelphia: Jaypee Brothers Medical Publishers, 2012. Chapter 18: The elbow and forearm complex; p. 642-648.
11. Kisner C, Colby L. Therapeutic Exercise Foundations and Techniques. 6th ed. Philadelphia: Jaypee Brothers Medical Publishers, 2012. Chapter 19: The Wrist and Hand; p. 702-704.
12. Vincent Connelly, Julie E. Dockrell& Jo Barnett (2005) The slow handwriting of undergraduate students constrains overall performance in exam essays, Educational Psychology, 25:1, 99-107, DOI: 10.1080/0144341042000294912
13. Younes, Tayseer. (2015). Correlation between Gross Motor Activities and Handwriting Skills in Elementary School Children. Trends in Applied Sciences Research. 10. 259-269. 10.3923/tasr.2015.259.269.
14. [Narici MV, Roi G, Landoni L, Minetti A, Cerretelli P. 1989. Changes in force, cross-sectional area and neural activation during strength training and detraining of the human quadriceps. Eur J Appl Physiol Occup Physiol 59: 310–319.
15. Joyner MJ, Coyle EF. 2008. Endurance exercise performance: The physiology of champions. J Physiol 586: 35–44.
16. Kamalanathan, P., & Banu H, S. (2017). Effects of Upper Limb Strengthening Exercises on Handwriting Speed in Undergraduate Students. International Journal of Pharmaceutical and Clinical Research 2017; 9(6): 475-479 doi: 10. 25258/ ijpcr. v9i6. 8778
17. Galbraith D, Roaf J, Rutherford SC., The role of handwriting in raising achievement [internet]. 2009 [cited 2009 May 02]. Available from: http:// www. literacytrust. org. uk/ research/ writing reviews. html