



**EFFECT OF HAND EXERCISES ON LONG WRITING TASK
IN SECONDARY SCHOOL STUDENTS**

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ABSTRACT

Writing is an essential form of communication in student's life. Their finger and wrist pain after writing for even a few minutes. A prospective study was conducted to investigate the effect of hand exercises on long writing task in secondary school students. 30 minutes of non-stop copy task followed with 12 sessions of 40-50 minutes exercise each. Number of words written, grip & pinch strength was measured using visual analogue scale (VAS) and hand dynamometer respectively. Visual analogue scale was compared pre and post exercise using paired t-test and correlation between grip, pinch strength and pain reduction using Pearson's Correlation. P-value (sig. value) from the statistic was 0.000 which is less than 0.05 showed a significant difference in pre and post treatment. Thus it concluded that handwriting speed; pinch and grip strength can be improved after the upper limb exercise program.

KEY WORDS: Handwriting Speed, Grip Strength, Pinch Strength, Hand Pain



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INTRODUCTION

Writing is an essential life skill, in daily-life, as a form of communication, expression of creativity and knowledge¹. Researchers have found that, students complain that they get tired after writing for even a few minutes. Their fingers and wrist pain due to long and continuous writing task. Endurance during handwriting task has not been given much attention and importance in school age population. Very few studies have been done on pain in the upper limb that is caused by writing. After writing for prolonged period of time muscles of forearm and intrinsic muscles of the hand gets fatigued as these are small muscles. Strengthening of these muscles can improve handwriting speed² Students who struggle to acquire and master handwriting skills may experience frustration and anxiety, which in turn may negatively affect overall performance in school. Students may need to take large number of notes. Intense activity of muscles causes pain and decline in performance. Performing a monotonous task for a long period of time induces pain and a decline in a person's ability to perform physical action. In one study, when children were asked to write long texts, hand pain had a significant effect on handwriting performance in children with both poor and good handwriting³. During resistive training muscle undergoes an isotonic contraction that is increase in intramuscular tension along with the change in length of muscle. Resistive training leads to increase in intramuscular tension. As intra-muscular tension increases there is gradual increase in muscle power leading to muscular hypertrophy. Due to hypertrophy of muscle there is improvement in endurance and strength of muscles⁴ This study attempts

to find the effect of hand exercises on reduced hand pain and also the relation of grip and pinch strength with pain related to long writing task

MATERIALS AND METHODS

Materials required

Soft ball, dumbbell, sand bag, rubber bands, plasticine, pen, stop watch, grip dynamometer, pinch dynamometer, A4 size paper, drawing paper, water colour, paint brush.

Study Design

The study was prospective and simple random sampling was done. The research protocol was approved by guide, institution. Ethical clearance was taken from the committee. Written consent was taken from the participants. Considering the inclusion criteria of students not having any orthopaedic and neurological problems and between ages 12 to 15yrs, 30 minutes of non-stop copy task was given. Exercise followed with 12 sessions of 40-50 minutes exercise each for 50 students (boys and girls). The number of words written and grip & pinch strength was measured using VAS and dynamometer respectively. The test was conducted for individual student on similar environment Hand exercises were given for 3 days/week for 4 weeks (45 minutes per session). Grip and pinch strength was measured and charted at the end of each week to check the improvement. At the end of 4th week (Post Exercise), the 30 minute writing task was repeated for the 50 identified subjects. Pain was measured with visual analogue scale (VAS)⁵

PHOTOGRAPHS

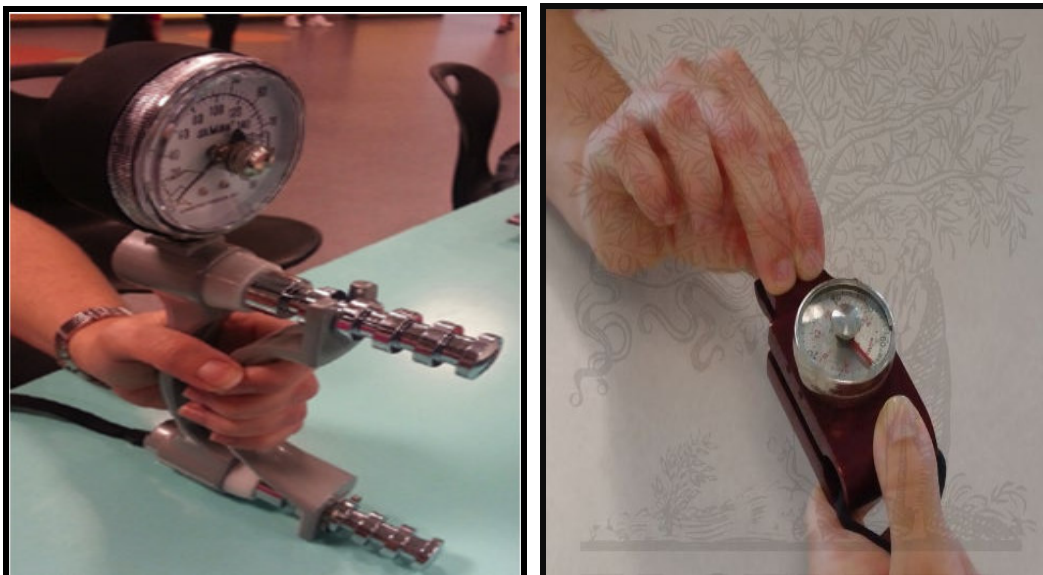


Photo I & II
Jamar Hand Dynamometer and Pinch Dynamometer



Photo 3 & 4
Strengthening Exercises



Photo 5 & 6
Testing Pinch and Grip Strength of Students

HYPOTHESIS

Alternate Hypothesis

Hand exercises have effect on hand pain during long writing task in secondary school students

Null Hypothesis

Hand exercises do not have effect on hand pain during long writing task in secondary school students

RESULTS

Data analysis was conducted using the Analysis Tools Statistical Package for Social Sciences (SPSS -Version 17) for descriptive statistics with the probability level set at 0.05.

- **Comparison between pre & post treatment on number of words**

Table No. 1

Calculation of std. deviation & std. error mean for # of Words				
	Mean	N	Std. Deviation	Std. Error Mean
Pre Treatment	242.78	50	112.342	15.888
Post Treatment	375.06	50	126.079	17.830

Inference

According to table 1 depicts that there is difference in mean of no. of words before and after the hand exercise and it has increased.

Table no. 2

Paired Sample t-test for pre & post treatment on number of words						
	Paired Differences		Std. Error Mean	95% Confidence Interval of the Difference		Sig. (2-tailed)
	Mean	Std. Deviation		Lower	Upper	

Inference

Table 2 indicates that there is a statistically significant difference between pre and post treatment on number of words.

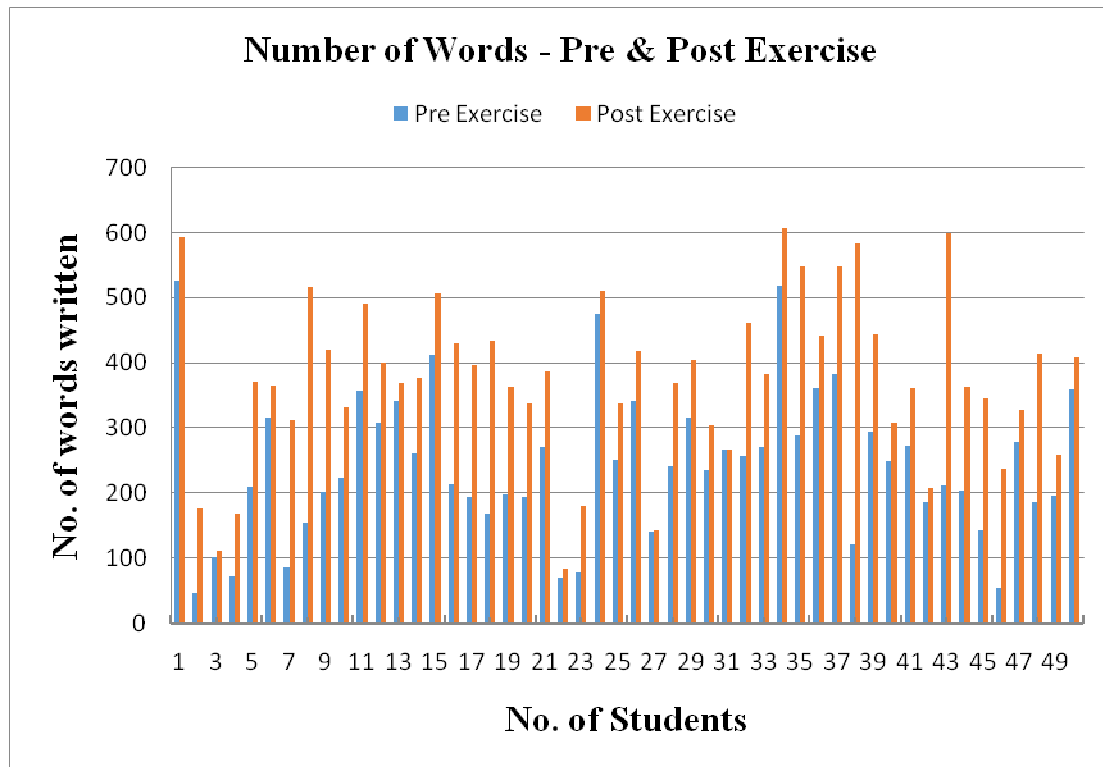


Figure 1
No. of Words - Pre & Post Exercise

- Comparison between pre & post treatment on grip strength

Table no. 3

Calculation of Std. Deviation & Std. Error Mean for Grip Strength			
	Mean	N	Std. Deviation
Grip Strength	20.31	50	5.695
Grip Strength Week 1	20.51	50	5.610
Grip Strength Week 2	20.83	50	5.555
Grip Strength Week 3	21.16	50	5.638
Grip Strength Week 4	22.05	50	5.399

Inference

Table 3 depicts that there is difference in mean of Grip Strength before and after the hand exercise and it has increased.

Table no. 4

Paired Samples t-test for pre & post treatment on grip strength						
Paired Differences						
	Std. Mean	Std. Deviation	95% Confidence Interval of the Difference		t	Sig.(2-tailed)
			Lower	Upper		
Grip Strength week 0 & 1	-.19	.410	-.058	-.310	-.077	3.33
Grip Strength week 0 & 2	-.51	.741	-.105	-.724	-.303	4.89
Grip Strength week 0 & 3	-.84	1.076	-.152	-1.152	-.541	5.56
Grip Strength week 0 & 4	-1.74	.936	-.132	-2.006	-1.47	13.1

Inference

Table 4 indicates that there is a statistically significant difference between pre and post treatment on Grip Strength.

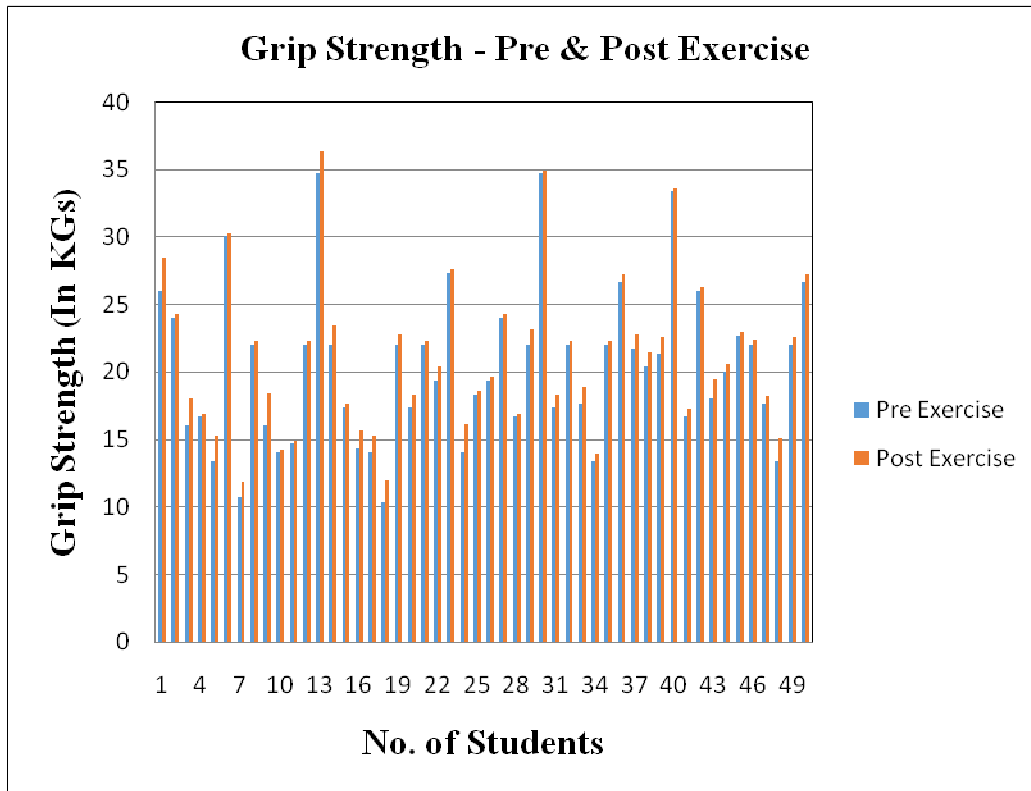


Figure 2
Grip Strength - Pre & Post Exercise

- **Comparison between pre & post treatment on Tip pinch strength**

Table no. 5

Calculation of Std. Deviation & Std. Error Mean for Tip Pinch Strength			
	Mean	Std. Deviation	Std. Error Mean
Tip Pinch Strength Week 0	2.71	500.846	0.120
Tip Pinch Strength Week 1	2.75	500.826	0.117
Tip Pinch Strength Week 2	2.79	500.789	0.112
Tip Pinch Strength Week 3	2.86	500.772	0.109
Tip Pinch Strength Week 4	3.09	500.760	0.108

Inference

Table 5 depicts that there is difference in mean of Tip Pinch Strength before and after the hand exercise and it has increased.

Table no. 6

Paired Samples t-test for pre & post treatment on Tip Pinch strength									
Paired Differences									
	Mean	Std. Deviation	Std. Error Mean	95% Interval Difference Lower	Confidence of the Upper	t	df	Sig. (2-tailed)	(2-
Tip Pinch Strength Week 0 & 1	-.040	.101	.014	-.069	-.011	-2.791	49	0.007	
Tip Pinch Strength Week 0 & 2	-.078	.151	.021	-.121	-.035	-3.669	49	0.001	
Tip Pinch Strength Week 0 & 3	-.148	.208	.029	-.207	-.089	-5.048	49	0.000	
Tip Pinch Strength Week 0 & 4	-.383	.213	.030	-.444	-.323	-12.728	49	0.000	

Inference

Table 6 indicates that there is a statistically significant difference between pre and post treatment on Tip Pinch Strength.

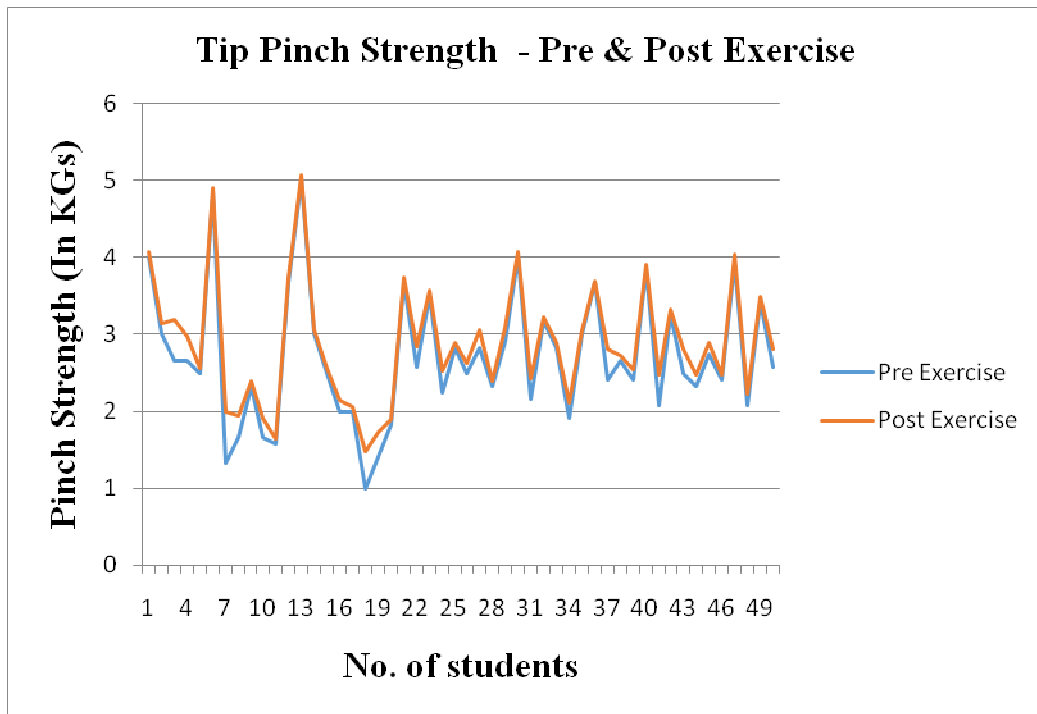


Figure 3
Tip Pinch Strength - Pre & Post Exercise

- Comparison between pre & post treatment on Tripod pinch strength

Table no. 7

Calculation of Std. Deviation & Std. Error Mean for Tripod Pinch Strength				
	Mean	N	Std. Deviation	Std. Error Mean
Tripod Pinch Strength Week 0	3.35	50	1.357	0.192
Tripod Pinch Strength Week 1	3.39	50	1.335	0.189
Tripod Pinch Strength Week 2	3.43	50	1.322	0.187
Tripod Pinch Strength Week 3	3.52	50	1.290	0.182
Tripod Pinch Strength Week 4	3.74	50	1.289	0.182

Inference

Table 7 depicts that there is difference in mean of Tripod Pinch Strength before and after the hand exercise and it has increased.

Table no. 8

Paired Samples t-test for pre & post treatment on Tripod Pinch strength						
Paired Differences						
		Std. Error Mean	95% Interval Difference Lower	Confidence of the Upper	t	Sig. (2-tailed)
Tripod Pinch Strength week 0 & 1	-.042	.104	-.071	-.012	-2.834	.007
Tripod Pinch Strength week 0 & 2	-.083	.167	-.131	-.036	-3.534	.001
Tripod Pinch Strength week 0 & 3	-.170	.234	-.236	-.104	-5.144	.000
Tripod Pinch Strength week 0 & 4	-.395	.224	-.459	-.331	-12.44	.000

Inference

Table 8 indicates that there is a statistically significant difference between pre and post treatment on Tripod Pinch Strength.

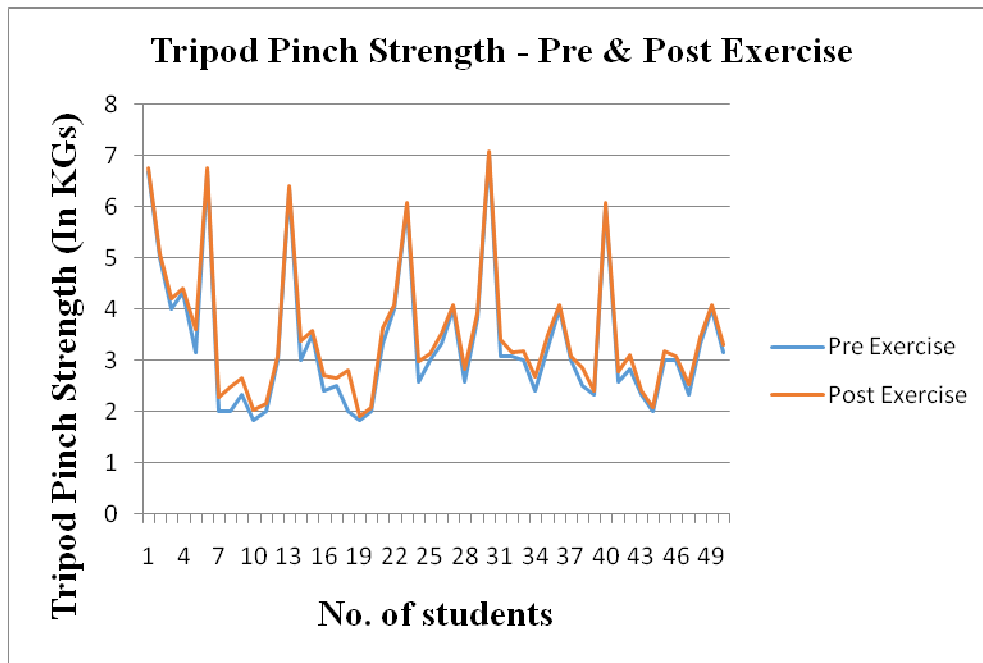


Figure 4
Tripod Pinch Strength - Pre & Post Exercise

- Correlation between pre & post treatment grip strength and reduction of pain

Table no. 9

Correlation between grip strength and pain reduction					
		Grip Strength post-treatment (week 4)	post-VAS treatment	post-Grip Strength pre-treatment (week 0)	VAS pre-treatment
Grip Strength post-treatment (week 4)	Pearson Correlation	1	-.727**	.987**	-.627**
VAS post-treatment	Pearson Correlation	-.727**	1	-.724**	.901**
Grip Strength pre-treatment (week 0)	Pearson Correlation	.987**	-.724**	1	-.626**
VAS pre-treatment	Pearson Correlation	-.627**	.901**	-.626**	1

** . Correlation is significant at the 0.05 level (2-tailed).

Inference

Table 9 indicates that there is inverse relation between the grip strength and pain reduction, as when grip strength increases, there is reduction in pain.

- Correlation between Tip pinch strength and reduction of pain

Table no. 10

Correlation between Tip Pinch Strength & Pain Reduction					
		Tip pinch Strength post-treatment (week 4)	post-VAS treatment	post-Tip pinch Strength pre-treatment (week 0)	VAS pre-treatment
Tip pinch Strength post-treatment (week 4)	Pearson Correlation	1	-.817**	.987**	-.727**
VAS post-treatment	Pearson Correlation	-.817**	1	-.724**	.901**
Tip pinch Strength pre-treatment (week 0)	Pearson Correlation	.987**	-.724**	1	-.824**
VAS pre-treatment	Pearson Correlation	-.727**	.901**	-.824**	1

** . Correlation is significant at the 0.05 level (2-tailed).

Inference

Table 10 indicated that there is inverse relation between the Tip Pinch Strength and pain reduction, as when Tip Pinch Strength increases, there is reduction in pain.

- **Correlation between Tripod pinch strength and reduction of pain**

Table no. 11

Correlation between Tripod pinch strength and reduction of pain					
		Tripod pinch Strength post-treatment (week 4)	VAS post-treatment	Tripod pinch Strength pre-treatment (week 0)	VAS Pre-treatment
Tripod pinch Strength post-treatment (week 4)	Pearson Correlation	1	-.864**	.987**	-.877**
VAS post-treatment	Pearson Correlation	-.864**	1	-.716**	.924**
Tripod pinch Strength pre-treatment (week 0)	Pearson Correlation	.987**	-.716**	1	-.876**
VAS pre-treatment	Pearson Correlation	-.877**	.924**	-.876**	1

** . Correlation is significant at the 0.05 level (2-tailed).

Inference

Table 11 indicated that there is inverse relation between the Tripod Pinch Strength and pain reduction, as when Tripod Pinch Strength increases, there is reduction in pain.

Pearson correlation coefficient *r* is as follows

$$r = r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}}$$

where:

r = Pearson correlation coefficient, *x* = Values in first set of data
y = Values in second set of data, *n* = Total number of values.

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$$

(The sample mean);

- **Comparison between pre & post treatment on pain reduction measured through VAS scale**

Table no. 12

Calculation of Std. Deviation & Std. Error Mean for pain reduction by Scale				
	Mean	N	Std. Deviation	Std. Error Mean
VAS Pre	4.10	50	0.707	0.100
VAS Post	2.92	50	0.877	0.124

Inference

Table 12 depicts that there is difference in mean of VAS Scale (Pain Scale) before and after the hand exercise and it has decreased.

Table no. 13

Paired sample t-test on pain reduction by VAS scale							
Paired Differences							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	<i>t</i>	df	Sig. (2-tailed)
				Lower	Upper		
VAS Pre - VAS Post	1.180	.523	.074	1.031	1.329	15.96	.000

Inference

Table 13 indicates that there is a statistically significant difference between pre and post treatment on VAS Scale (Pain Scale).

The test statistic is calculated as

$$t = \frac{\bar{d}}{\sqrt{s^2/n}}$$

Where \bar{d} is the mean difference, s^2 is the sample variance, n is the sample size and t is a Student t quantile with $n-1$ degrees of freedom.

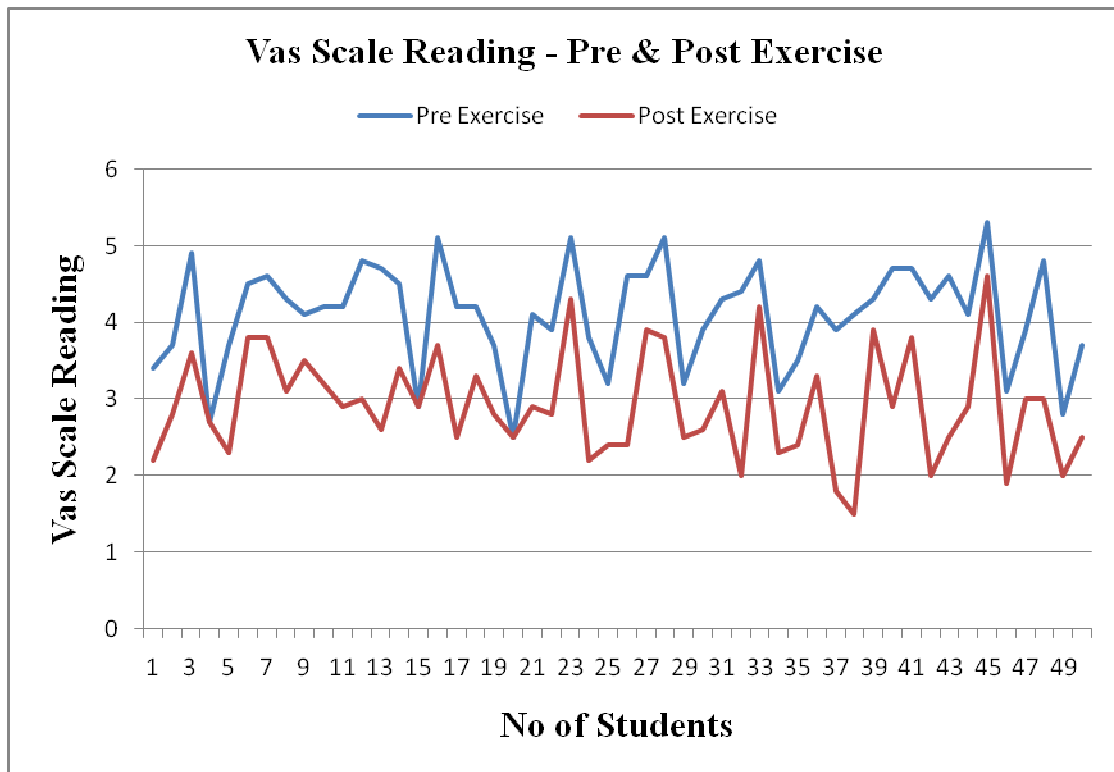


Figure 5
Vas Scale Reading - Pre & Post Exercise

DISCUSSION

The result of this study supports previous findings that upper limb exercises increase the handwriting speed. The significant main effect for lengthy task indicated that upper limb exercises have an influence on pain during long writing task. Muscle strength of the hands and fingers increases as children grow and participate in everyday activities. Activities such as climbing, playing with toys or scribbling with crayons all help to develop and strengthen the muscles of the hands and fingers. This knowledge will help student to strengthen the upper limb and improve the duration of lengthy writing tasks. Figure 1; suggest that there is significant difference in the No. of Words after 4 weeks of strengthening exercises of distal upper limb muscle. The result can be seen because during resistive training muscles undergo isotonic contraction which gradually increases the muscle power, due to hypertrophy of muscle there is improvement in strength and endurance of muscles.⁶ The overall analysis of Figure 2, 3, 4 suggest that there was significant improvement in grip and pinch strength and has a significant impact on increasing pain reduction as their p -value < 0.05 . Strength training increases muscle size. Fast twitch fibres show greater hypertrophy along with increase in contractile protein content. The muscle hypertrophy increased strength associated with strength

training has a substantial impact on the grip and pinch strength in students. The result of analysis of VAS showed significant improvement in students with pain during long writing task. The improvement ranged from 4.10 (pre exercise) to 2.92 (post exercise) from 7 days to 28 days with 3-4 sessions. Students with persisting pain indicate a worse grade of disorder in which the musculoskeletal structures have not been able to recover from the high demand. Strength and flexibility of muscles, the position of the pen grip and the overall posture of the writer affect the final output^{7,8}. Above all, students should be taught not to practise through pain as has been the custom in the past. Better hand writing speed will help quick assimilation of knowledge and perform well at examination. Thus help in achieving higher academic grades. A comprehensive strength training program can help students with pain during long writing task achieve greater confidence to accomplish more demanding task and ultimately result in greater academic performance.

CONCLUSION

In this study it is found that there is a high correlation between grip strength, pinch strength (Tip and Tripod) and reduction of pain. Therefore, Null hypothesis is rejected and alternate hypothesis is accepted. Thus in essence, this study concludes that upper limb exercises

are highly effective in reducing pain during long writing task in secondary school students. Handwriting speed,

pinch and grip strength can be improved after upper limb exercise program.

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