International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Effect of Hand Exercise Program on Grip Strength, Endurance and Handwriting Speed among Physiotherapy Students

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Abstract

Background: Handwriting is an important functional and academic activity among physiotherapy students. It requires coordinated interaction between the musculoskeletal and neuromotor systems of the upper limb. Adequate hand grip strength and muscular endurance may contribute to sustained writing performance, particularly during prolonged academic activities. Previous research has demonstrated that exercise-based interventions can improve handwriting speed and hand strength among students. However, limited evidence is available regarding the combined effect of a structured hand exercise Program on grip strength, hand endurance, and handwriting speed specifically among physiotherapy students.

Objective: To determine the effect of a structured hand exercise Program on grip strength, hand endurance and handwriting speed among physiotherapy students.

Methodology: An experimental pre-test and post-test study was conducted among 30 physiotherapy students aged 18–25 years. Participants meeting the eligibility criteria were included in the study. Baseline assessment of grip strength, hand endurance, and handwriting speed was performed before commencement of the intervention. Participants underwent a structured hand exercise Program for 4 weeks, with sessions conducted 5 days per week for approximately 15 minutes per session. The intervention consisted of hand gripper squeezing, therapeutic putty exercises, rubber-band finger extension exercises, and ball-squeezing exercises. Grip strength was assessed using a hand dynamometer, hand endurance was assessed using a ball-squeezing endurance test, and handwriting speed was assessed using a standardized 100-word writing task. Post-intervention assessment was performed using the same procedures.

Results: A total of 30 participants completed the study, with no dropouts. Post-intervention assessment demonstrated improvement in grip strength, hand endurance, and handwriting speed compared with baseline values. Statistical analysis demonstrated a significant improvement in all three outcome measures following the intervention.

Conclusion: The findings indicate that a structured 4-week hand exercise Program may be effective in improving grip strength, hand endurance and handwriting speed among physiotherapy students. Incorporating simple hand strengthening and endurance exercises into the routine of physiotherapy students may be beneficial for improving hand function required for prolonged academic writing activities.

Keywords: Hand Exercise, Grip Strength, Hand Endurance, Handwriting Speed, Physiotherapy Students

Introduction

Hand function is an essential component of academic and professional activities performed by physiotherapy students. Students frequently engage in prolonged writing during lectures, examinations, practical records, case documentation, and academic assignments. Handwriting is a complex skilled motor activity that requires coordinated control of the fingers, hand, wrist, and upper limb along with appropriate visual-motor integration and sustained muscular activity.

Handwriting involves fine and precise movements of the upper extremity and depends on the interaction of musculoskeletal, neurological, and perceptual-motor systems. The speed and quality of handwriting may be influenced by several factors, including hand strength, muscular endurance, coordination, posture, writing technique, pen grip, and sustained attention. Research investigating handwriting performance has demonstrated that upper-limb motor performance and perceptual motor factors are relevant to writing speed. [1]

Grip strength is an important indicator of functional hand performance and can be objectively measured using a hand dynamometer. Adequate grip strength is required for holding and controlling a writing instrument and for performing repetitive hand activities. Hand endurance is also important because prolonged writing requires the hand and forearm muscles to maintain activity over an extended period without excessive fatigue.

Previous research among students has demonstrated an association between hand grip strength, hand endurance, and writing speed. Tayyab et al. reported a positive association between hand grip strength, endurance and writing speed among undergraduate students. [2] Similarly, Butt et al. found moderate positive relationships between hand grip strength, hand endurance and writing speed among students and suggested that exercises aimed at improving strength and endurance may contribute to better writing performance. [3]

Exercise-based interventions have also been investigated for improving handwriting performance. Nilukshika et al. conducted a 4-week structured upper-limb exercise Program among undergraduate students and reported significant improvements in handwriting speed, palmar pinch grip strength, and upper-limb coordination. [4] The study demonstrated that a structured exercise Program performed regularly over several weeks could positively influence handwriting-related performance.

Gokulakrishnan and Franklin investigated upper-limb strengthening exercises among undergraduates and reported improvement in both handwriting speed and grip strength following a 4-week exercise Program. [5] These findings provide support for the use of strengthening exercises as a strategy to improve hand-related academic performance.

Hand exercise programs commonly incorporate resistive and functional exercises directed towards the intrinsic and extrinsic muscles of the hand and forearm. Hand grippers, therapeutic putty, elastic resistance, and squeezing exercises can provide progressive resistance and repetitive muscular activity. Such exercises may improve muscular strength and endurance and may consequently facilitate sustained hand function.

Although previous studies have examined handwriting speed and its relationship with hand strength, comparatively limited research has investigated a structured hand exercise

program incorporating both strengthening and endurance components in physiotherapy students while simultaneously evaluating grip strength, endurance and handwriting speed.
Therefore, the present study was undertaken to determine the effect of a structured hand exercise Program on grip strength, hand endurance and handwriting speed among physiotherapy students.

Aim of the Study

To determine the effect of a structured hand exercise program on grip strength, hand endurance, and handwriting speed among physiotherapy students.

Objectives of the Study

1. To assess pre intervention grip strength, endurance and handwriting speed among physiotherapy students.
2. To assess post intervention grip strength, endurance, and handwriting speed among physiotherapy students.
3. To compare the pre and post intervention results to determine the effectiveness of the hand exercise program.
4. To analyze the relationship between improved grip strength, endurance, and handwriting speed among physiotherapy students.

Hypothesis

Research Hypothesis

There will be a significant improvement in grip strength, hand endurance and handwriting speed among physiotherapy students following a structured hand exercise Program.

Null Hypothesis

There will be no significant improvement in grip strength, hand endurance and handwriting speed among physiotherapy students following a structured hand exercise Program.

Methodology

Study Design

An experimental pre-test and post-test study design was used.

Study Population

The study population consisted of physiotherapy students.

Sample Size

A total of 30 physiotherapy students participated in the study.

Age Group

Participants aged 18–25 years were included.

Sampling Method

Purposive Sampling

Study Setting
The study was conducted at TMV's Indutai College of Physiotherapy, Pune.

Study Duration
The intervention was conducted for a period of 4 weeks.

Inclusion Criteria
Participants were included if they:
1. Physiotherapy students.
2. Age group between 18 and 25 years of age.
3. Normal Body mass index {BMI}.

Exclusion Criteria
Participants were excluded if they had:
1. Any current musculoskeletal injury or pain affecting the upper limb or hand.
2. Any neurological condition affects hand function.
3. Any recent surgery or trauma involving the upper limb.
4. Any condition that could interfere with performance of the exercise Program or outcome measurements.

Ethical Considerations
Ethical permission was obtained by TMV's Indutai Tilak College of Physiotherapy, Pune before commencement of the study. Participants were informed about the purpose and procedures of the study. Written informed consent was obtained from all participants before participation. Confidentiality of participant information was maintained throughout the study.

Outcome Measures
The following outcome measures were assessed:

Grip Strength
Grip strength was measured using a hand dynamometer. The participant was positioned according to the standardized testing procedure, and the dynamometer was used to obtain the grip-strength measurement. The recorded value was expressed in kilograms.

Hand Endurance
Hand endurance was assessed using a ball-squeezing endurance test. Participants were instructed to repeatedly squeeze the therapy ball for the specified duration while maintaining the required effort. The endurance performance was recorded according to the study protocol.

Handwriting Speed
Handwriting speed was assessed using a standardized 100-word paragraph. Participants were instructed to write the provided paragraph as accurately and quickly as possible under standardized conditions. The time required to complete the task was recorded, and handwriting speed was expressed in words per

minute (WPM).

Intervention Protocol

Participants underwent a structured hand exercise Program for 4 weeks, 5 days per week, with each session lasting approximately 15 minutes.

The intervention consisted of the following exercises:

1. **Hand Gripper Squeezing**

Participants performed hand-gripper squeezing to provide resisted grip-strengthening activity.

Dosage: 3 sets × 15 repetitions.

2. **Therapeutic Putty Exercises**

Therapeutic putty was used for different hand and finger strengthening activities, including:

- Pinching
- Rolling
- Finger spreading

These exercises were performed to activate the intrinsic and extrinsic muscles of the hand and improve hand function.

3. **Rubber-Band Finger Extension**

A rubber band was placed around the fingers and resisted finger extensions were performed.

Dosage: 3 sets × 15 repetitions.

4. **Ball-Squeezing Exercise**

Participants performed repeated squeezing of a therapy ball to improve hand muscular endurance.

Dosage: 2 sets × 1 minutes.

The exercises were supervised to ensure appropriate technique and adherence to the prescribed protocol.

Procedure

After obtaining informed consent, baseline demographic information was recorded. Pre-intervention measurements of grip strength, hand endurance, and handwriting speed were obtained using standardized procedures.

Participants were then instructed and supervised in the structured hand exercise Program. The Program was performed 5 days per week for 4 consecutive weeks.

Following completion of the intervention, post-intervention measurements were obtained using the same assessment procedures and equipment used during the baseline assessment.

All 30 participants completed the intervention and post-intervention assessment, with no dropouts.

Statistical Analysis

Data were entered and analyzed using SPSS Microsoft Excel 2026.

Descriptive statistics were used to summarize the study variables. Mean and standard deviation were calculated for the outcome measures.

A paired statistical test was used to compare pre-intervention and post-intervention values because the same participants were assessed before and after the intervention.

The level of statistical significance was set at $\mathbf{p < 0.05}$.

[Formula used: Average to find mean, used STDEV.S which estimate standard deviation of given samples two tailored inversed students t- distribution to find t-value using sign

formula coated with T.INV.2T (two tailored inversed student t distribution to find probability). To get t test value we need to find p-value which return probability of students t test with two distribution and 1 paired test.]

Results

A total of 30 physiotherapy students participated in the study. All participants completed the 4-week intervention Program and post-intervention assessment, resulting in a 100% completion rate with no dropouts.

The comparison of pre-intervention and post-intervention values demonstrated improvement in all three primary outcome measures: grip strength, hand endurance, and handwriting speed.

Participant Characteristics

Table 1: Age Distribution of Participants

Age (years)	Number of Subjects
21	1
22	16
23	9
24	2
25	2

The participants had a mean age of 22.60 ± 0.93 years. The largest age group was 22 years (n = 16).

Table 2: Participant Characteristics by Gender and Dominant Hand

Characteristic	Category	n
Gender	Female	24
Gender	Male	6

Dominant hand	Right	26
Dominant hand	Left	4

Comparison of Pre-Intervention and Post-Intervention Outcome Measures

Table 3: Comparison of Pre-Intervention and Post-Intervention Grip Strength, Hand Endurance and Handwriting Speed

Outcome Measure	Pre-test Mean ± SD	test Mean ± SD	Mean Difference	Paired t-value	p-value
Grip strength	17.17 ± 12.08	21.27 ± 13.04	4.10	16.06	<0.001
Hand endurance	25.10 ± 7.27	30.57 ± 7.34	5.47	13.46	<0.001
Handwriting speed	21.37 ± 2.97	26.90 ± 3.63	5.53	18.79	<0.001

Grip Strength

The mean grip strength increased from **17.17 ± 12.08 kg** at pre-intervention assessment to **21.27 ± 13.04 kg** at post-intervention assessment.

The difference between pre-intervention and post-intervention grip strength was statistically significant (**p = 5.69594E-16**).

Figure 1: Pre-Intervention and Post-Intervention Grip strength

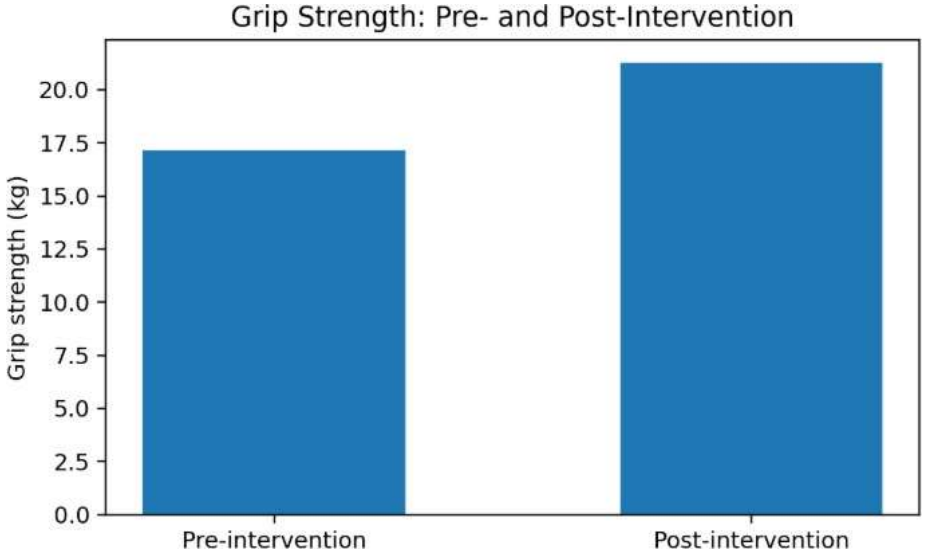

Table 1: Comparison of Pre-Intervention and Post-Intervention Grip Strength

Variable	-intervention Mean ± SD	-intervention Mean ± SD	Mean Difference	p-value
Grip strength (kg)	17.17 ± 12.08 kg	21.27 ± 13.04 kg	4.10	5.69594E-16

Hand Endurance

The mean hand endurance increased from **25.10 ± 7.27 at** pre-intervention assessment to 30.57 **±7.34** at post-intervention assessment.

The improvement in hand endurance was statistically significant (**p = 5.2835E-14**)

Figure 2: Pre-Intervention and Post-Intervention Hand endurance

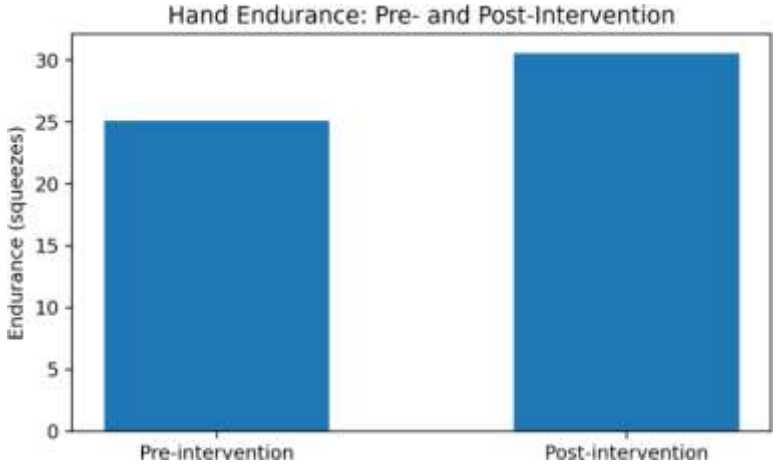

Table 2: Comparison of Pre-Intervention and Post-Intervention Hand Endurance

Variable	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean Difference	p-value
Hand endurance	**25.10 ± 7.27**	**30.57 ±7.34**	**5.47**	**5.2835E-14**

Handwriting Speed

The mean handwriting speed increased from **21.37 ± 2.97 WPM** at pre-intervention assessment to **26.90 ± 3.63 WPM** at post-intervention assessment.

The improvement in handwriting speed was statistically significant (**p = 8.87865E-18**).

Figure 3: Pre-Intervention and Post-Intervention Handwriting speed

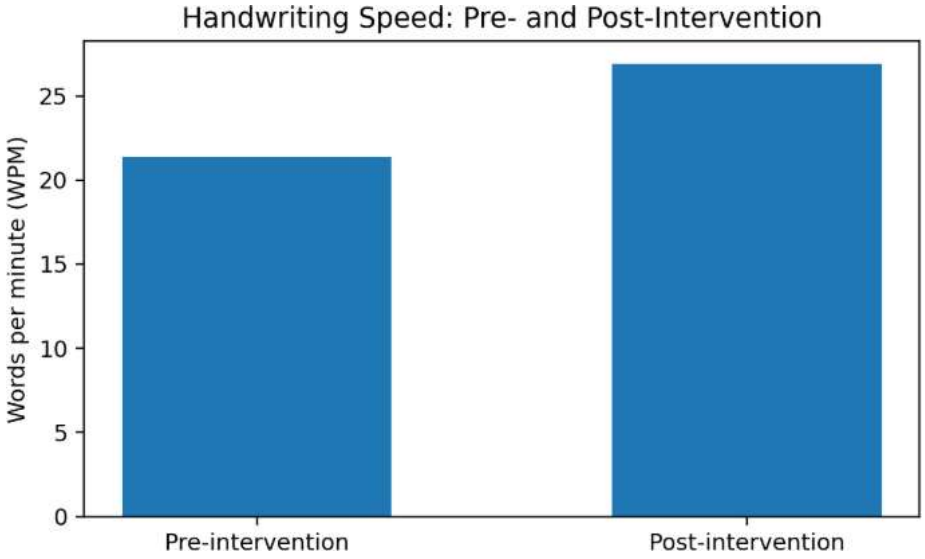

Table 3: Comparison of Pre-Intervention and Post-Intervention Handwriting Speed

Variable	e-intervention Mean ± SD	t-intervention Mean ± SD	Mean Difference	p-value
Handwriting speed (WPM)	21.37	26.90	5.53	8.87865E-18

Overall Findings

Overall, the findings demonstrated statistically significant improvement in grip strength, hand endurance and handwriting speed following the 4-week structured hand exercise Program.

Table 5: Overall Mean and Standard Deviation of Spreadsheet Variables

Variable	Pre-test Mean	Post-test Mean	Mean Difference	Standard Deviation of Difference
Grip strength	17.17	21.27	4.10	1.40
Hand endurance	25.10	30.57	5.47	2.22

Handwriting speed	21.37	26.90	5.53	1.61

Discussion

The present study investigated the effect of a structured hand exercise Program on grip strength, hand endurance and handwriting speed among physiotherapy students. The findings demonstrated significant improvement in all three outcome measures following 4 weeks of intervention.

The improvement in grip strength may be attributed to the repeated resisted contractions produced through hand-gripper exercises, therapeutic putty exercises, and ball squeezing. Repeated resistance exercise provides a stimulus for adaptation of the muscles involved in gripping and finger movements. The combination of different forms of resistance in the present Program may have provided a comprehensive strengthening stimulus to the hand of musculature.

The findings are consistent with the study by Gokulakrishnan and Franklin, who reported improvement in grip strength following a structured upper-limb strengthening Program among undergraduate students. [5] Their findings support the potential role of strengthening exercises in improving hand function and handwriting-related performance.

The significant improvement in hand endurance observed in the present study may be related to the repeated and sustained contractions required during ball squeezing and other repetitive hand exercises. Endurance of the hand and forearm musculature is particularly relevant during prolonged writing because the muscles must maintain adequate force and control over an extended period.

Tayyab et al. reported an association between grip strength, endurance and writing speed among undergraduate students, supporting the importance of hand strength and endurance in writing-related activities. [2] Butt et al. similarly reported moderate positive relationships between hand grip strength, hand endurance and writing speed among Doctor of Physical Therapy students. [3]

A significant improvement in handwriting speed was also observed following the intervention. The improvement may be related to enhanced hand strength, muscular endurance, and repeated practice of controlled hand movements. Improved muscular capacity may allow participants to maintain more consistent force of production and control during writing, potentially reducing fatigue during prolonged writing tasks.

The findings are supported by Nilukshika et al., who demonstrated significant improvement in handwriting speed following a 4-week upper-limb exercise Program conducted 5 days per week. Their study reported a 21% improvement in handwriting speed following the intervention. [4] The similarity in intervention duration and frequency provides support for the present findings.

Gokulakrishnan and Franklin also reported improvement in handwriting speed after a 4-week upper-limb strengthening Program among undergraduate students. [5] These findings collectively suggest that structured exercise directed towards the hand and upper limb may have a beneficial effect on handwriting performance.

The present study specifically focused on physiotherapy students, a population in which handwriting remains relevant for examinations, academic documentation, practical records, and clinical education. Therefore, improvement in hand strength and endurance may have functional relevance beyond the measured outcome of handwriting speed.

The present findings should nevertheless be interpreted in consideration of the study design and sample characteristics. The study involved a relatively small sample of 30 physiotherapy students and used a

pre-test and post-test design without a separate control group. Therefore, future studies involving larger samples, randomized controlled designs, and longer follow-up periods may provide stronger evidence regarding the effectiveness and sustainability of the intervention.

Conclusion

The present study concluded that a structured 4-week hand exercise Program was effective in improving grip strength, hand endurance and handwriting speed among physiotherapy students.

The significant improvement observed across all three outcome measures suggests that a simple, structured Program consisting of hand strengthening and endurance exercises can be incorporated into student exercise Programs to support hand function and handwriting performance.

Clinical Implications

The findings of the study suggest that hand exercise Programs may be considered as a simple and practical intervention for improving hand strength and endurance in students who perform prolonged writing activities.

Physiotherapy professionals and educators may consider incorporating shorthand exercise sessions into student wellness or academic-performance Programs, particularly for students who experience hand fatigue during prolonged writing.

Limitations

The study used a pre-test and post-test design without a separate control group.

Recommendations

Future studies may consider:

1. Conduct randomized controlled trials with larger sample sizes.
2. Comparing the hand exercise Program with a control or alternative intervention group.
3. Evaluating additional handwriting-related parameters such as writing quality, fatigue, and perceived hand discomfort.
4. Investigating the effectiveness of the Program among students from different academic disciplines.

Acknowledgement

The authors would like to express their sincere gratitude to Dr Reshma Nipunge, the Department of Physiotherapy, TMV's Indutai College of Physiotherapy, Pune, and all the participants who contributed to the successful completion of the study.

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