

Original Article

Association of Hand Grip Strength and Hand Writing Speed Among School Students

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Abstract

Objective: The purpose was to identify the association of hand grip strength and hand writing speed among school students and to find out if there is any gender-based variation between hand grip strength and hand writing speed.

Study Design: An Analytical cross-sectional study was conducted.

Place and duration of study: This study was conducted at Faisal Model High School, Sadiqabad, Rawalpindi, and All City Leadership School and College, Rawalpindi, Pakistan, from June 2025 to November 2025.

Material and Methods: An analytical cross-sectional study was conducted with a sample size of 200 school students from Rawalpindi, aged between 12-17 years. Data was collected using hand dynamometer and words per minute test. Data was analyzed by using SPSS version 26.

Results: Statistical results showed significant relation between gender and hand grip strength ($p < 0.01$), gender and hand writing speed ($p < 0.05$). There was no significant correlation between hand grip strength and hand writing speed ($p > 0.05$).

Conclusion: The study concludes that both males and females had faster hand writing speed but males showed stronger grip strength as compared to females.

Keywords: Hand grip strength, hand writing speed, dynamometer, words per minute test, hand dominance.

1. Introduction

Grip strength is the force generated by the muscles in the hand and forearm, for movements like writing, grabbing, squeezing, and twisting. It's essential for handling objects, whether holding, pulling, lifting, or carrying, and determines how heavy an object can be managed⁽¹⁾. The hand has 11 intrinsic and 15 extrinsic muscles that serve functional tasks. Grip power comes from both extrinsic and intrinsic hand muscles⁽²⁾.

Muscle strength has been investigated across multiple populations in relation to individual and other variables such as gender, age, and hand dominance. It is also influenced by growth-related factors, including height, weight, and body mass index (BMI).⁽³⁾ Literature indicates a positive relationship between grip strength and multiple factors including the BMI, gender and age groups.⁽⁴⁾

Handwriting is a vital skill for school-aged children, supporting academic progress,

participation, and self-esteem. Strong handwriting skills are essential for academic success, while difficulties can lead to underachievement and impact performance in writing tasks⁽⁵⁾. Handwriting evaluations should consider writing speed, readability, and observational aspects related to writing execution. Correct and consistent letter formation, stance, and pencil hold are all part of execution⁽⁶⁾. Handwriting needs the ability to manage the pen between the thumb and fingers while maintaining precise control of dynamic forces on the pen tip to create letter shapes and keep the pen from slipping in the hand. At the same time, appropriate force should be delivered downwards onto the sheet to mark the paper⁽⁷⁾. Weak grip-force dynamics were linked to reduced legibility, poor handwriting form, and longer writing duration, providing insight into the effects of grip force on handwriting⁽⁸⁾.

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Measuring the strength of each muscle group separately can be time consuming. Therefore, having one quick and simple tool to estimate overall muscle strength is helpful. For this purpose, to measure handgrip strength, dynamometer is often used, because it is inexpensive, easy to perform, and can be measured quickly in clinical settings⁽⁹⁾. The dynamometer is regarded as the gold standard tool (and its reliability is 85% to 95%) for determining grip strength and endurance. Using a hand dynamometer, the grip strength of the hand showed the total muscle strength in kilogram. Whereas the writing speed is measured by words per minute test⁽¹⁰⁾. The handgrip strength of healthy individuals were measured using a hand dynamometer. It was recommended that the usual indicated handgrip strength value can be interpreted and evaluated according to age and gender.⁽¹¹⁾

A study conducted in 2022 by Marcia K. Schneider et al, suggests that an inefficient grasp can lead to decreased handwriting speed and increased fatigue⁽¹²⁾. The study conducted by Francisco José Amo-Seiten et al., found a positive association was found between physical fitness and academic performance variables. Results showed good physical fitness (i.e., muscular strength and endurance) appears to support better academic performance (i.e., writing speed).⁽³⁾

Literature showed, males found to have stronger grip strength and faster writing speeds than females due to physiological differences and varying social Experiences.⁽¹³⁾

A study conducted by Gokulakrishnan J* and John Franklin in 2020, reported a high correlation between grip strength and writing speed ⁽¹⁴⁾. Physical therapy plays important role in improving the strength and endurance of intrinsic muscle of hand.⁽¹⁵⁾

2. Materials & Methods

The study was a cross-sectional study with a sample size of 200 students. This study was conducted over a period of 6 months, following the approval of the research synopsis, from June 2025

to November 2025. The sample size was calculated using the Rao Soft sample size calculator, assuming a moderate correlation ($r = 0.3$), a 95% confidence interval, and 80% power. The study population consisted of students enrolled in grades 9th and 10th from Faisal Model High School, Sadiqabad, Rawalpindi, and All City Leadership School and College, Rawalpindi.

Sample Selection

Sample was selected on the basis of inclusion and exclusion criteria.

Inclusion Criteria

Students were willing to participate in the study. Both male and female students were included to ensure representation of both genders. Students between 12 and 17 years of age were eligible to participate in the study.

Exclusion Criteria

Students who were not willing to participate in the study were excluded. Students with any fracture or deformity of the hand or skin were also excluded. In addition, students with any pathology affecting the dominant hand or those who had undergone recent surgery of the hand or wrist were excluded from the study.

Tools

Following tools were used for the evaluation of participants: hand grip strength was measured by a gold standard tool dynamometer, whereas handwriting speed was measured by Words Per Minute test (WPM).

Data Collection Procedure

After approval from the Institutional Review Board (IRB), data were collected from the target population after obtaining informed consent.

Maximal grip strength was measured using a dynamometer, with three maximal contractions (T1, T2, and T3) recorded with adequate rest between trials to prevent fatigue. The dynamometer was reset to zero before each measurement. Writing speed was assessed using the Words Per Minute (WPM) test. Participants were provided with a printed paragraph and instructed to copy it for one minute. The papers were then collected, and the total number of words written was counted and recorded as the writing speed in words per minute.

3. Results

The gender distribution of participants is, Out of 200 participants, 104 (52%) were male and 96 (48%) were female. Table 1 showed out of 200 participants, 106 were in 9th grade and 94 were in 10th grade, regarding hand dominance 179 were right handed and 21 were left-handed. HGS and handwriting-speed values were grouped into equal-width categories (9 kg bands for HGS; 8 WPM bands for handwriting speed) spanning the observed range, to allow comparison across gender and hand-dominance subgroups. HGS had an approximate mean of 24.2 ± 10.9 kg and handwriting speed an approximate mean of 30.1 ± 5.9 words per minute; as shown in figures 1 and 2.

Table 1

Grade and Hand dominance of participants

Grade		Hand dominance	
9th	106 (53%)	Right-handed	179 (89.5%)
10th	94 (47%)	Left-handed	21 (10.5%)

Figure 1: Gender and handgrip strength

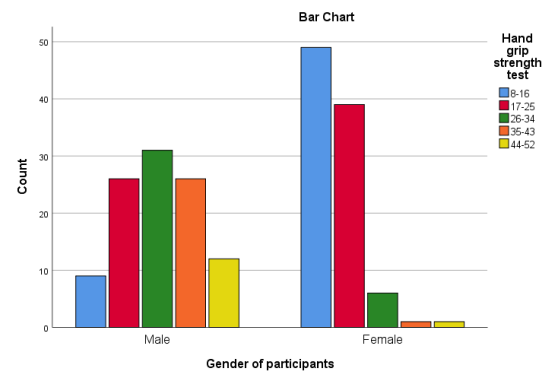
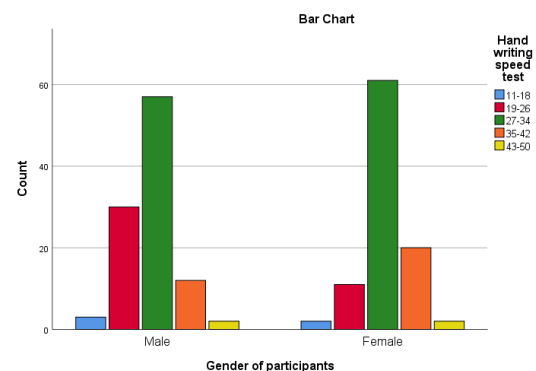


Figure 2: Gender and Hand writing speed test



Out of 200 participants, 58 (29%) participants showed HGS of 8-16kg, 65 (32.50%) showed HGS of 17-25kg, 37 (18.50%) showed HGS of 26-34kg, 27 (13.50%) showed HGS of 35-43kg and 13 (6.50%) showed HGS of 44-52kg. And 5 (2.50%) participants showed handwriting speed of 11–18 words per minute, 41 (20.50%) showed handwriting speed of 19–26 words per minute, 118 (59.00%) showed handwriting speed of 27–34 words per minute, 32 (16.00%) showed handwriting speed of 35–42 words per minute, and 4 (2.00%) showed handwriting speed of 43–50 words per minute.

Chi-square test showed a statistically significant association between gender and hand grip strength ($p < 0.01$), indicating that hand grip strength distribution differed significantly by gender. Males had higher frequencies than females in the 26–34

(31 vs. 6), 35–43 (26 vs. 1), and 44–52 (12 vs. 1) kg categories, while females had higher frequencies in the 8–16 (49 vs. 9) and 17–25 (39 vs. 26) kg categories.

A significant association was also found between gender and handwriting speed ($p=0.028$). Males had higher frequencies than females in the 11–18 (3 vs. 2) and 19–26 (30 vs. 11) categories, whereas females had higher frequencies in the 27–34 (61 vs. 57) and 35–42 (20 vs. 12) categories. Both males and females had 2 participants in the 43–50 category.

Chi-square test showed no significant association between hand dominance and hand grip strength ($p=0.29$). Right-hand-dominant students had higher frequencies than left-hand-dominant students in all HGS categories: 8–16 (55 vs. 3), 17–25 (54 vs. 11), 26–34 (34 vs. 3), 35–43 (24 vs. 3), and 44–52 (12 vs. 1) kg.

A significant association was found between hand dominance and handwriting speed ($p<0.01$). Right-hand-dominant students had higher frequencies than left-hand-dominant students in the 11–18 (5 vs. 0), 19–26 (35 vs. 6), 27–34 (105 vs. 13), and 35–42 (32 vs. 0) categories, while both groups had 2 participants in the 43–50 category. The highest frequency for both groups was observed in the 27–34 category.

Non-parametric Spearman's correlation analysis showed a weak positive correlation between age and hand grip strength, with a correlation coefficient of 0.175 and a statistically significant result ($p=0.013$, $p<0.05$). This indicates that hand grip strength slightly increased with age. In contrast, no correlation was found between age and handwriting speed, with a correlation coefficient of -0.020 and a non-significant result ($p=0.780$,

$p>0.05$). The analysis included 200 participants ($N=200$).

Spearman's correlation analysis showed no correlation between hand grip strength and hand writing speed ($p=0.000$, $p=0.996$, $N=200$). This indicates that hand grip strength and hand writing speed were unrelated in this sample. The chi-square test on the categorized data ($\chi^2=11.364$, $df=16$, $p=0.786$) gave the same result.

Degrees of freedom (df) for each chi-square test were calculated as $(\text{number of rows} - 1) \times (\text{number of columns} - 1)$ and are reported together with the chi-square value (χ^2) and significance.

The chi-square results show that gender was significantly associated with both hand grip strength ($\chi^2=79.341$, $df=4$, $p<0.001$) and hand writing speed ($\chi^2=10.838$, $df=4$, $p=0.028$), and hand dominance was associated with hand writing speed ($\chi^2=11.761$, $df=4$, $p=0.019$) but not with hand grip strength ($\chi^2=4.950$, $df=4$, $p=0.292$). No significant association was found between hand grip strength and hand writing speed ($\chi^2=11.364$, $df=16$, $p=0.786$). The dominance–handwriting result should be interpreted cautiously because only 21 students were left-handed.

The Spearman correlation coefficient of 0.000 ($p=0.996$) means there was no linear or rank-order relationship between hand grip strength and hand writing speed; students with stronger grip did not write faster or slower than students with weaker grip.

Spearman's correlation also showed that gender had a strong negative correlation with hand grip strength ($p=-0.616$, $p<0.001$), indicating that males had markedly higher grip strength than females, and a weak positive correlation with hand writing speed ($p=0.213$, $p=0.002$), indicating that females

tended to write slightly faster. Age had a weak positive correlation with hand grip strength ($\rho=0.175$, $p=0.013$) but none with hand writing speed ($\rho=-0.020$, $p=0.780$). Hand dominance was not significantly correlated with either hand grip strength ($\rho=0.035$, $p=0.619$) or hand writing speed ($\rho=-0.059$, $p=0.403$).

Table 2

Association between hand grip strength and hand writing speed

	Hand-grip strength test					Total	P-value
	8-16	17-25	26-34	35-43	44-52		
Hand-writing speed test	11-18	2	2	0	1	0	0.786
	19-26	11	15	8	3	4	
	27-34	33	38	22	17	8	
	35-42	12	7	6	6	1	
	43-50	0	3	1	0	0	
Total	58	65	37	27	13	200	

4. Discussion

This study determined the association of hand grip strength and hand writing speed among 200 school students, age between 12 to 17 years. Out of 200 participants 104 (52%) were male, 96 (48%) female, and 179 (89.5%) were right-handed, 21 (10.5%) left-handed. Results showed a significant ($p < 0.01$) relation between gender, grip strength, and hand writing speed ($p < 0.05$). There was no significant ($p > 0.05$) relation between hand dominance and hand grip strength, but significant ($p < 0.05$) relation between hand dominance and hand writing speed. Non-parametric Spearman's analysis showed significant but weak correlation between age and hand grip strength ($\rho=0.175$, $p=0.013$), no correlation between age and hand writing speed ($\rho=-0.020$, $p=0.780$), hand grip strength and hand writing speed ($p > 0.05$). While several of these associations reached statistical significance, this does not necessarily indicate a clinically meaningful or causal relationship; the magnitude of the correlations (e.g., $\rho=0.175$

between age and HGS) was weak, and effect sizes should be interpreted alongside p-values rather than in place of them.

In 2022, Butt et al conducted an associational study to investigate a relation between hand grip strength and endurance on hand writing speed. A total of 113 healthy DPT students were recruited by convenient sampling at AMNC. Data collection tool Jamar Dynamometer and letter per minute test were used to collect data. Results indicate strong positive correlation ($r=0.95$) between grip strength and endurance, ($r=0.57$) showed moderate correlation between hand power and hand writing speed ⁽¹⁰⁾. Current study had same aim to find out the association of hand grip strength using assessment tools dynamometer but words per minute test used for the hand writing speed. In contrast to previous study, current study showed that there was no correlation between hand grip strength and hand writing speed ($p > 0.05$).

Tayyab et al. (2019) studied the association between hand grip strength and handwriting speed in 87 undergraduate DPT students using a dynamometer and letter-per-minute test. They found that 77% of females with minimal strength (< 23 kg) had better endurance and could write more letters than stronger females, while 23% of males with maximal strength (> 37.5 kg) showed better endurance and handwriting speed ⁽¹⁵⁾. Similarly, the current study used a dynamometer and words-per-minute test and showed that, based on frequency distributions alone, a larger proportion of females fell into the higher handwriting-speed categories despite lower hand grip strength, and a larger proportion of males fell into the higher hand-grip-strength categories. Group-level means estimated from the frequency data in Table 4.3 support this pattern (approximate mean handwriting speed: females 31.3 WPM vs.

males 29.0 WPM); however, an independent-samples t-test on the raw (non-categorized) data is recommended to confirm whether this difference is statistically significant before drawing a firm conclusion about hand grip strength and handwriting speed.

A cross sectional study conducted by Gayathri Pradeep et al. examined the relationship between handgrip strength, pinch force, and handwriting speed among young adults. A sample of 127 students aged 18–22 years, recruited in study after taking informed consent. Demographic information was collected through a questionnaire, and handgrip strength and pinch force were assessed using a JAMAR hand dynamometer and pinch gauge. Handwriting speed was determined by calculating the number of words written each minute. The findings revealed significant ($p \leq 0.05$) gender differences, males had much better handgrip and pinch strength, whereas females had significantly ($p \leq 0.05$) faster handwriting speed⁽¹⁶⁾. Current study also investigates the relation between hand grip strength and hand writing speed by using hand dynamometer and words per minute test, results were same as previous study that males had better hand grip strength ($p < 0.01$) than females, in contrast to previous study, current study reveals significant ($p < 0.05$) relation regarding gender and hand writing speed i.e., both males and females had fast hand writing speed.

It should be noted that the comparison studies differed methodologically from the current study, particularly in the population sampled (DPT/undergraduate students vs. school-aged children) and in the unit used to measure handwriting speed (letters per minute vs. words per minute), which limits direct comparability of results. Several potential confounding variables may have influenced the observed associations,

including age, sex, hand dominance, height, weight/BMI, grade, writing language, prior handwriting training, and fatigue. In the present study, only age, gender, grade, and hand dominance were recorded (height, weight/BMI, writing language, prior handwriting training, and fatigue were not measured); only bi-variate chi-square and Spearman correlation tests were used, and no adjusted or multivariate analysis (e.g., multiple regression) was conducted. Future studies should consider adjusting for these variables to isolate the independent contribution of grip strength to handwriting performance.

Conclusion

The current study found no significant correlation between hand grip strength and handwriting speed ($p > 0.05$), which was the primary research question of this study.

As secondary findings, significant associations were observed between gender and HGS ($p < 0.01$), gender and handwriting speed ($p < 0.05$), and hand dominance and handwriting speed ($p < 0.01$), and age showed a weak correlation with HGS ($p = 0.175$, $p = 0.013$).

Limitations

Some of the limitation of the study were:

- In current study, convenient sampling was used.
- Sample size was small, was taken from few schools in Rawalpindi which limits the generalizability of results.
- Current study did not investigate the ergonomics or sitting posture of the students.
- The cross-sectional design does not allow causal inferences to be drawn between hand grip strength and handwriting speed.

- Hand-dominance groups were markedly unbalanced (179 right-handed vs. 21 left handed), limiting the reliability of comparisons between these groups.
- Potential confounding variables (e.g., height, weight/BMI, prior handwriting training, fatigue) were not fully accounted for in the analysis.
- Categorizing continuous HGS and handwriting-speed measurements into groups may have reduced statistical power and information compared to analyzing them as continuous variables.

Recommendations

This study provides valuable information and understanding of handgrip strength and handwriting speed patterns with respect to age and gender, although the present findings do not support the idea that increasing grip strength will necessarily improve handwriting speed.

Additionally, future researches recommended to use probability sampling to reduce selection bias. A bigger sample size from several schools might increase the accuracy and reliability of the findings. Furthermore, ergonomic considerations such as chair height, desk design, sitting position, and writing surface should be considered, as these can all affect hand-grip strength and handwriting performance. Controlling these variables may provide a more complete knowledge of the factors influencing handwriting speed in school students.

Disclosure /Conflict of interest:

Authors declare no conflict of interest.

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