

Association between Handedness, Grip Strength and Writing-Speed Among Young Undergraduates in South-West, Nigeria

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Abstract

Background: Writing-speed plays a crucial role in various academic and professional disciplines and it is an unavoidable part of students' activities. Previous studies have explored different factors that influence writing-speed among students, However, there is dearth of literature on the role of handedness and grip strength on writing-speed among this population. **Aims:** To investigate the association among each of handedness, grip strength and writing-speed. **Methods:** 368 undergraduates of Bowen University, were recruited into this cross-sectional study using consecutive sampling technique. Mean, frequency, percentages and pie charts were used to describe the data; Mann-Whitney U, Spearman rank correlation and Chi-square test was used for inferential analysis at alpha level set at 0.05. **Results:** Mean age of participants' 20 ± 2 years and most of the participants were right handed (77.7%). There was significant relationship ($p=0.00$) between age and grip strength. There was no significant relationship between age ($p=0.164$) and writing-speed and between grip strength ($p=0.108$) and writing-speed. While there were no significant

differences between grip strength ($p=0.062$) or writing-speed ($p=0.116$) and handedness, significant differences were found between gender and both grip strength ($p=0.025$) and writing-speed ($p=0.00$). There was significant association ($p=0.00$) between handedness and gender. **Conclusion:** The study found that males had stronger grip strength and faster writing speeds than females, likely due to physiological differences and varying social experiences. Handedness did not significantly impact grip strength or writing speed, suggesting other factors like practice are more influential. Age correlated positively with grip strength but did not affect writing speed, likely due to muscle development. The association between gender and handedness may reflect both biological and cultural influences. These findings highlight the importance of considering gender and age in motor skills research.

Keywords: Handedness, Grip strength, Writing-speed, Undergraduates

INTRODUCTION

Handwriting is a well-designed activity that requires the synchronization of a number of person's skills ⁽¹⁾. Handwriting depends on the development and integration of Visual Perceptual, cognitive and fine motor system ability ⁽²⁾. Smooth writing is created by combined and synchronized movements of individual for sensory motor feedback and visual monitoring simultaneously ⁽²⁾. There are some important sensory motor parameters that include grip strength and handedness which are essential for their satisfactory actions ⁽¹⁾. Since handwriting-speed and the capacity to communicate knowledge are closely related, both have a significant impact on academic performance ⁽³⁾. Effective documentation is paramount in healthcare settings to ensure accurate patient records efficient communication between healthcare providers and legal compliance. Handedness is the most blatant behavioral asymmetry observed in humans and is manifested by the preferential use of one hand over the other for a specific task ⁽⁴⁾. Based on self-reports, approximately 90% of the population is right-handed. The notion that hand preference may be localized to a specific cerebral hemisphere was first suggested by Liepmann ⁽⁵⁾ following an earlier discovery by Wernicke ⁽⁶⁾ regarding the specific localization of language in the left hemisphere. Recent findings have supported the hypothesis of an association between hemispheric lateralization of hand dominance and language centers ⁽⁶⁾.

Handedness has been associated with the lateralization of specific cortical activations in the primary motor cortex ⁽⁷⁾, cingulate motor area, supplemental motor areas, and cerebellar

regions during the performance of sensorimotor tasks ⁽⁸⁾. For right-handers, left-hand movements are under more direct neural control of the right than left hemisphere and may benefit from this hemisphere's better representation of the coordinates of spatial locations ⁽⁹⁾ ⁽¹⁰⁾. This, in turn, may explain the left-hand's ability to precisely position the fingers and adapt to subtle differences in processing spatial information related to proprioceptive information ⁽⁸⁾. Such limb differences have contributed to further investigations into asymmetries in processing sensory-based information ⁽¹⁰⁾. The grip is the ability of the hand to grasp objects between the fingers and thumb, it is well believed that grip and pinch strength assessments give an objective indication of upper extremity functional integrity ⁽¹¹⁾. Gripping, manipulation, and expressiveness are the primary tasks of the hand. ⁽¹¹⁾. Most of the previous studies were done on undergraduate students' handwriting-speed. Grip strength is evaluated as a module of hand function (American Society of Hand Therapists), hand grip strength just not only used to demonstrate the importance of the hand but also to signify as entire upper extremity strength ⁽¹⁾. Grip strength of hand shows overall muscle strength that is measured using a hand dynamometer. To measure the grip strength and endurance, dynamometer is declared as a gold standard test ⁽¹⁾. Grip strength basically tests the isometric contraction of the hand according to ⁽¹⁾. Additionally, it was discovered that there are variances based on gender, with males having stronger dominant hand grips ⁽¹⁾. To determine the relation between 3 parameters ⁽¹⁾ used a dynamometer for the measurement of strength and endurance. For the assessment of hand writing-speed the authors used Letters per minute Test was used. The report of the study showed a high correlation of strength and endurance, and a moderate positive correlation of handwriting-speed and strength also, there was a moderate positive correlation of handwriting and endurance ⁽²⁾. A forceful contraction of muscles is normally required for picking and pulling of objects but a sustained isometric contraction is what is required for holding any object ⁽²⁾. However, in handwriting, both strength and endurance are required for movement of pen and holding pen vertically, so both characteristics of the muscles of hand strength and endurance are required for better handwriting and speed ⁽¹⁾. Thus going through all the literature that showed a positive relationship between strength, endurance and writing-speed, students can improve their academic performance through exercises that increase hand strength and endurance which in turn increase their writing-speed ⁽¹²⁾. From the above, it is obvious that studies have established a relationship between grip strength, hand endurance and

handwriting-speed, conversely, there is paucity of literature establishing a relationship between handedness, grip strength and handwriting-speed, hence the crux of this study.

MATERIALS AND METHODS

Participants for this study were consenting undergraduates of Bowen University, Iwo, Osun state, Nigeria. however, ambidextrous students were excluded from this study. Consecutive sampling technique was used to recruit participants for this cross sectional study. sample size was calculated using the Slovin's formula ⁽¹³⁾. Ethical approval was sought and obtained from Bowen University Teaching Hospital Health Research and Ethics Committee before the commencement of this study. Informed consent was obtained from prospective participants prior to completing the questionnaire. The purpose of the study was explained to the participants. Materials and instruments used were the words per minute per minute test which is a standardized assessment ⁽¹⁴⁾ used to measure the rate at which individuals can write a series of words within a specified time frame of 1 minute, a sociodemographic form and a data collection sheet were also used to obtain data from participants, a dynamometer and a stop watch were also used. The participants were asked indicate their hand dominance, then they are seated with the shoulder adducted, elbow flexed to 90 degrees, and forearm and wrist in neutral position. The researcher then placed the dynamometer in the participants's dominant hand while gently supporting the base of the dynamometer, and he instructed the participants to squeeze on the device as hard as possible for 5 seconds exerting a strong grip force. Grip force should be applied smoothly, without a rapid jerking motion and also to allow the wrist to extend during the grip.

The dynamometer records the maximum force exerted by the hand muscles during the grip test measured in the unit kilograms (kg). The recorded grip strength measurement was then recorded for analysis. Writing-speed was measured using the word per minute test ⁽¹⁴⁾ The participants were provided with the test sheet, which contains an array of words arranged randomly. The participants were instructed to write as fast as they could the words arranged in an array in the test sheet. Emphasizing the importance of accuracy as well as speed. Participants strove to write each word correctly, avoiding errors such as misspellings or illegibility.

A predetermined time limit of one minute was set for the task. The examiner ensured that the participant was aware of the time limit. When the time limit expired, participants stopped writing immediately, even if they had not finished the passage. The total number of complete words written by the participant during the one-minute time period was recorded as their writing-speed. Descriptive statistics of mean, mode, and standard deviation was used to summarize socio-demographic data. Chi-square test was used to determine the association between gender and handedness of participants. Spearman rank correlation was used to determine relationship between handedness, grip strength and writing-speed of participants. Mann-Whitney u test was used to determine the differences in grip strength and writing-speed of males and female participants. All data analysis was done using SPSS version 23 and alpha level will be set at 0.05.

RESULTS

368 participants were included in this study to determine the relationship among each of handedness, grip-strength and writing-speed. Most of the participants 228(62.0%) were between the ages of 16 to 20, and 158(42.3%) were 22 years old and above (Table 1). The mean age of participants was 20. The mean grip strength and writing-speed of the participants was 49 and 40 respectively. Majority 228(62%) of the participants were males and 140(38%) were females. On handedness, a majority 286(77.7%) of the participants were right handed, while 82(23.3%) were left handed. There was weak negative correlation ($r=-0.084$) between Grip strength and Writing-speed which was statistically not significant ($p=.108$). However, there was a significant difference ($p= 0.000$) in grip strength among male and female participants, in writing-speed among male and female participants ($p= 0.025$) table 2 and 3 respectively. There was no significant difference ($p= 0.062$) in grip strength and handedness, in writing-speed and handedness ($p= 0.116$) the of participants. There was weak negative correlation ($r=-0.073$) between age and Writing-speed of participants which was not statistically significant ($p=.164$). There was moderate positive correlation ($r=0.277$) between Grip strength and age of participants which was significant ($p=.000$). There was statistically significant association between gender ($p=.000$) and handedness of participants.

Table 1: Sociodemographic variables of the Respondents

| Variabiles | Frequency n=368 | Percentage(%) |
|-------------------|------------------------|----------------------|
| Handedness | | |
| Left | 82 | 22.3 |
| Right | 286 | 77.7 |
| Gender | | |
| Male | 228 | 62.0 |
| Female | 140 | 38.0 |
| Age(years) | | |
| 16-20 | 228 | 62.0 |
| 21-25 | 136 | 37.0 |
| >26 | 4 | 1.1 |

Table 2: Difference in Grip strength among male and female participants.

| Variabiles | U score | Grip strength (p value) |
|-------------------|----------------|--------------------------------|
| Gender | 4688.00 | 0.000* |
| Male | | |
| Female | | |

***P Significant at ≤ 0.05**

Table 1: Relationship between Grip strength and Writing-speed variables

| Variabiles | r | Grip strength (P value) |
|-------------------|----------|--------------------------------|
| Writing speed | -0.084 | 0.108 |

Table 4: Differences in writing-speed among male and female participants

| Variables | U score | writing-speed p-value |
|---------------|-----------|--------------------------|
| Gender | 13744.500 | 0.025* |
| Male | | |
| Female | | |

*P Significant at ≤ 0.05

Table 5: Differences between writing-speed and handedness of participants.

| Variables | U score | Writing speed P value |
|-------------------|-----------|--------------------------|
| Handedness | 10392.500 | 0.116 |
| Right | | |
| Left | | |

Table 2: Differences in grip strength and handedness of participants.

| Variables | U score | Grip strength p value |
|-------------------|-----------|--------------------------|
| Handedness | 10143.500 | 0.062 |
| Right | | |
| Left | | |

DISCUSSION

This study was designed to determine the relationship among each of grip strength, handedness and writing-speed among young University undergraduates in South western State in Nigeria. There was a significant percentage of right handed participants in the study which is because there is a higher percentage of right handed individuals ⁽¹⁵⁾ in the world. This finding is similar to a study conducted by ⁽¹¹⁾ which accounts for 85.9% of right handed participants. A study conducted by ⁽¹¹⁾ found that right-handed individuals had a 10% stronger grip in their right hand compared to their left hand, while left-handed individuals showed a less pronounced difference between hands. Leyk and others in 2007 conducted a study involving 15,132 participants aged 17 to 89 years ⁽¹⁴⁾. The findings

indicated that men had significantly higher grip strength than women across all age groups. For example, according to the authors, men aged 20-29 had an average grip strength of 54.4 kg, while women in the same age group had an average of 35.6 kg. This was concurrent with the findings of our study indicating the significant difference between the male and female ($p=0.000$) grip strength.

Another study conducted by ⁽¹⁾ found moderate correlation between grip strength and writing-speed. This is not in agreement with the findings of our study as there was weak negative correlation between Grip strength and Writing-speed which was statistically not significant ($p=0.108$). The contrast in findings could be attributable to the difference in sample size, the study by ⁽¹⁾ involved only 113 healthy young adult students while our study included a larger sample size of 368 students. There was also a weak negative correlation between Grip strength and Writing-speed which was statistically not significant. The lack of significant relationship between grip strength and writing-speed suggests that writing-speed may be most influenced by factors other than grip strength, such as handedness, age, cognitive load, writing tools and material, anxiety and stress. However, the negative relationship implies that as grip strength increases, writing-speed might decrease, and vice-versa. This is open for further research in order to explore the factors responsible for this relationship.

The study revealed a significant difference in grip strength between male and female participants, with males exhibiting stronger grip strength. This finding aligns with other studies, such as those by ⁽¹⁵⁾ ⁽¹⁶⁾ which consistently reported that males generally have greater upper body strength compared to females. These differences can be attributed to physiological factors such as higher muscle mass, greater hand size, and elevated testosterone levels in males, which contribute to their superior grip strength. Compared to females, who typically have less muscle mass and smaller hand size, males tend to perform better in grip strength tests across various age groups. This significant difference underscores the importance of considering sex-specific factors in physical assessments and the design of interventions in sports, rehabilitation, and ergonomics. The analysis revealed a significant difference in writing-speed between male and female participants, with males writing faster ($p = 0.025$). This finding aligns with existing research, such as studies by Feder & Majnemer ⁽¹⁷⁾, which suggest that males often have an advantage in tasks requiring fine motor skills, including writing, possibly due to factors like hand size and muscle

strength. These results highlight the importance of considering gender differences in educational settings, particularly in tasks where speed is critical.

The analysis of grip strength and handedness using the Mann-Whitney U test showed no significant difference between participants' grip strength and their handedness. This result suggests that handedness does not have a strong influence on grip strength, aligning with a study by ⁽¹⁵⁾ that found minimal or no difference in grip strength between dominant and non-dominant hands in left- and right-handed individuals. These findings indicate that while handedness might influence other motor skills, it may not be a determining factor for grip strength, highlighting the need for further research to explore other contributing factors. The analysis of writing-speed and handedness using the Mann-Whitney U test indicated no significant difference between participants' writing-speed and their handedness. This finding suggests that handedness does not significantly impact writing-speed, which aligns with a study by ⁽¹⁸⁾ that have found minimal influence of handedness on writing performance. These results imply that other factors, such as practice, education, or individual motor skills, may play a more substantial role in determining writing-speed than handedness alone.

The Spearman's correlation analysis showed a weak negative correlation between age and writing-speed of participants, which was not statistically significant. However, this results suggests that as age increases, writing-speed may slightly decrease, but the relationship is not strong or statistically significant. These findings indicate that age may have a minimal impact on writing-speed, and other factors might play a more crucial role in influencing how quickly individuals can write. This result is consistent with a study by ⁽¹⁹⁾ that found age-related declines in motor skills to be subtle and not uniformly significant across all tasks. The Spearman's correlation analysis revealed a moderate positive correlation between grip strength and age of participants, which was statistically significant. This finding suggests that as age increases, grip strength also tends to increase, at least within the age range of the study participants. This significant positive relationship may reflect the development and accumulation of muscle strength over time, particularly during the years when individuals are physically active and engaging in strength-building activities. However, it is important to consider that this trend might reverse in older age groups, where muscle strength typically declines ⁽¹⁶⁾.

The Chi-square test analysis indicated a statistically significant association between gender and handedness among participants ($p = 0.000$). This result suggests that gender may influence handedness, with certain handedness patterns being more prevalent in one gender than the other. The finding aligns with research indicating that males and females may differ in their handedness distribution, often with a higher prevalence of left-handedness in males ⁽²⁰⁾. This association highlights the importance of considering gender when studying handedness and its related characteristics.

CONCLUSION

It was concluded that there is a higher association between gender and writing-speed as compared to factors such as grip strength, handedness and age, which could be caused by the anatomical and physiological differences between both genders. Understanding and addressing the broader range of factors that contribute to writing-speed in undergraduate students is crucial for improving their overall health and well-being and academic performance. Preventive measures such as regular breaks, ergonomic interventions and exercise programs to reduce the risk of fatigue is highly recommended. Furthermore, regular exercises, grip strengthening and proper education on handedness to prevent switching handedness due to mythologies which can have an impact on the fluency and writing-speed of those individuals as these factors have been associated with higher writing-speed is encouraged.

Additionally, the findings of this study hold important implications for management, business, and education, particularly in areas where written communication and productivity are critical. The observed differences in grip strength and writing speed between males and females highlight the need for ergonomic considerations in designing workspaces and learning environments. Adjustable chairs, desks, and writing tools that accommodate different grip strengths can reduce fatigue and improve performance. In the educational sector, such measures could enhance students' comfort during examinations and long writing tasks, ultimately supporting better academic outcomes. Similarly, employers and educators should also recognize the potential impact of gender and motor skills on writing speed when evaluating individuals for tasks requiring extensive written output. In business, roles such as administrative support or customer service may demand fast and accurate documentation, while in education, students are often assessed under time

constraints. Providing training to improve writing speed and efficiency could help individuals perform more effectively, whether in the workplace or classroom.

Moreover, technology offers a practical solution to reduce disparities in writing performance. Tools such as speech-to-text software and digital note-taking devices can assist individuals with slower writing speeds. In education, these tools ensure that students are not disadvantaged during tests or lectures. Similarly, in professional settings, they promote equity and allow all employees to contribute effectively. These interventions can improve productivity, inclusivity, and satisfaction across both sectors.

Future Research Directions

This study lays the groundwork for further research into the relationship between handedness, grip strength, and writing speed. One key direction is to conduct longitudinal studies to explore how these factors change over time, particularly as individuals age or transition through different stages of education or career development. Such research could offer insights into the long-term effects of motor skill changes on productivity and performance. Another important area for investigation is the cultural factors influencing handedness and writing speed. Differences in societal norms, educational practices, and cultural attitudes may explain variations in writing preferences and performance across populations. Research in this area could help institutions design inclusive strategies that account for diverse needs.

REFERENCES

1. Butt K, Maqbool S, Fatima U, Arif M, Arooj A, Amir L, Noor F, Zaheer B. Effect Of Hand Grip Strength and Endurance on Writing Speed Among Students of DPT In AMNC: Hand Grip Strength on Writing Speed Among Students. *Pakistan BioMedical Journal*. 2022 Aug 31:22-6.
2. Tseng MH, Chow SM. Perceptual-motor function of school-age children with slow handwriting speed. *The American Journal of Occupational Therapy*. 2000 Jan 1;54(1):83-8.
3. Desrosiers J, Bravo G, Hebert R, Dutil E. Normative data for grip strength of elderly men and women. *The American Journal of Occupational Therapy*. 1995 Jul 1;49(7):637-44.
4. Corey DM, Hurley MM, Foundas AL. Right and left handedness defined: a multivariate approach using hand preference and hand performance measures. *Cognitive and Behavioral Neurology*. 2001 Jul 1;14(3):144-52.
5. Liepmann H. *The left hemisphere and action*. London, Ontario: University of Western Ontario. 1905.

6. Wernicke C. Der aphasische Symptomencomplex: eine psychologische Studie auf anatomischer Basis. Cohn & Weigert; 1874.
7. Ashe J, Georgopoulos AP. Movement parameters and neural activity in motor cortex and area 5. *Cerebral cortex*. 1994 Nov 1;4(6):590-600.
8. Viviani P, Perani D, Grassi F, Bettinardi V, Fazio F. Hemispheric asymmetries and bimanual asynchrony in left-and right-handers. *Experimental Brain Research*. 1998 May;120:531-6.
9. Laeng B, Peters M. Cerebral lateralization for the processing of spatial coordinates and categories in left-and right-handers. *Neuropsychologia*. 1995 Apr 1;33(4):421-39.
10. Kosslyn SM. Seeing and imagining in the cerebral hemispheres: a computational approach. *Psychological review*. 1987 Apr;94(2):148.
11. Incel NA, Ceceli E, Durukan PB, Erdem HR, Yorgancioglu ZR. Grip strength: effect of hand dominance. *Singapore medical journal*. 2002 May 1;43(5):234-7.
12. Massy-Westropp NM, Gill TK, Taylor AW, Bohannon RW, Hill CL. Hand Grip Strength: age and gender stratified normative data in a population-based study. *BMC research notes*. 2011 Dec;4:1-5.
13. Slovin E. Slovin's formula for sampling technique. Retrieved on February. 1960 Jul 2;13:2013.
14. Graham, S., Berninger, Weintraub & Shafer (1998). Development of handwriting speed and legibility in grades 1-9. *Journal of Educational Research*, 92, 42-52.
15. *Llaurens V, Raymond M, Faurie C. Why are some people left-handed? An evolutionary perspective Philos Trans R Soc Lond B Biol Sci 2009364(1519)881–894. [DOI] [PMC free article] [PubMed]*
16. Leyk D, Gorges W, Ridder D, Wunderlich M, Rütther T, Sievert A, Eßfeld D. Hand-grip strength of young men, women and highly trained female athletes. *European journal of applied physiology*. 2007 Mar;99:415-21.
17. Petersen P, Petrick M, Connor H, Conklin D. Grip strength and hand dominance: challenging the 10% rule. *The American journal of occupational therapy*. 1989 Jul 1;43(7):444-7.
18. Dodds RM, Syddall HE, Cooper R, Benzeval M, Deary IJ, Dennison EM, Der G, Gale CR, Inskip HM, Jagger C, Kirkwood TB. Grip strength across the life course: normative data from twelve British studies. *PloS one*. 2014 Dec 4;9(12):e113637.
19. Feder KP, Majnemer A. Handwriting development, competency, and intervention. *Developmental Medicine & Child Neurology*. 2007 Apr;49(4):312-7.
20. Feder KP, Majnemer A, Bourbonnais D, Blayney M, Morin I. Handwriting performance on the ETCH-M of students in a grade one regular education program. *Physical & Occupational Therapy in Pediatrics*. 2007 Jan 1;27(2):43-62.
21. Peters M, Murphy K. Cluster analysis reveals at least three, and possibly five distinct handedness groups. *Neuropsychologia*. 1992 Apr 1;30(4):373-80.
22. Salthouse TA, Fristoe N, Rhee SH. How localized are age-related effects on neuropsychological measures?. *Neuropsychology*. 1996 Apr;10(2):272.