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Effects of Pen Diameter And Pen Grip on Handwriting Speed In High-School Students.

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Abstract
Writing is an essential skill required from early childhood and is needed in entire life. But writing performance is most important in student's life,especially in highschool. Completing the papers in time with good handwriting is a task many students are worried for. Many studies have been performed regarding pressure point, writing instrument and surface. This study was conducted to find out the effects of pen diameter and pen grip on handwriting speed in high school students. 60 students were included in the study out of which 40 were females and 20 were males. All the students were given a paragraph in English language and they were instructed to copy the same first with their daily used pen within a minute. After this they were given a large diameter pen and asked to rewrite the paragraph again within a minute. For calculation of speed words written per minute were counted. Type of grip used by each student was noted down by observing.Average hand writing speed with large diameter pen was 25.76+/-3.264 and hand writing speed with regular diameter pen was 23.06+/-3.404. The results of this study suggests that pen diameter has an effect on handwriting speed. Writing with large diameter pen provides faster speed as compared to the regular diameter pen. The average hand writing speed with tripod grip was 25+/-3.10 and with quadropod grip was 22+/-2.7. The results show that grip type has an effect on hand writing speed. In this study Tripod grip provided faster hand writing speed than that of the quadropod grip.

Keywords: pen, handwriting speed, pen diameter, type of pen grip, writing performance

Introduction
The writing action involves joints ofupper extremity. The stability is provided by shoulder joint , elbow gives support & other primary actions take place at wrist and fingers.[1]
Handwriting is fine motor skill which is required to all the human beings. [2] Actions that are frequently used by students which n demands writing,is to record notes and most importantly to complete exams particularly in high school.[2]Students who struggle to acquire and master handwriting skills may experience frustration and anxiety which intern may negatively affect overall performance.[2]
Writing is an essential life skill which is mandatory for everyone to have in today's circumstances. And it forms an intrinsic part of student's life, which is required at every level may it be primary, secondary or tertiary. [3] It is a complex integration of three systems mainly, muscular, skeletal, and neurological systems which coordinate together.[3] Handwriting is affected by many factors such as anatomy of extremity, general physical and mental health & acuity also writing instrument and surface.[4] The final result is affected by Strength and flexibility of muscles, the position of pen grip and overall posture.[4]
Hand writing process includes main movement that takes place at the forearm while shoulder provides power with minimum movement occurring at wrist and fingers.[5] During writing ,when the pencil is moved forward ,the interrosi flexes the MPjoint (metacarpophalangeal joint)& extends PIP (Proximal interphalangeal joint) & DIP (distal interphalangeal joint) joints. When pencil is brought back EDC extends the MP joint & EDS flexes PIP joints.[5]
Muscle work involved in writing is also coordinated skilfully with upper limb muscles. Muscles of shoulder, elbow wrist & fingers work together to perform the skilful action of writing. Extensor

carpi radialislongus is a long muscle which is responsible for the movements of wrist joint ,it extends wrist & adducts hand. Abduction of the thumb & wrist is performed by Abductor pollicislongus& it also flexes the hand. The extensor carpiulnaris works to extend the wrist. The extensor digitorium muscle of forearm extends the medial 4 digits of the hand. Extensor digitoriumcommunis muscle helps to extend the phalanges , wrist , & elbow. Flexor digitorium superficial is muscle of a forearm that flexes the proximal interphalengial joints. Flexor digitorumprofundus is a muscle of deep forearm that is used in action o flexon of the fingers.[1]

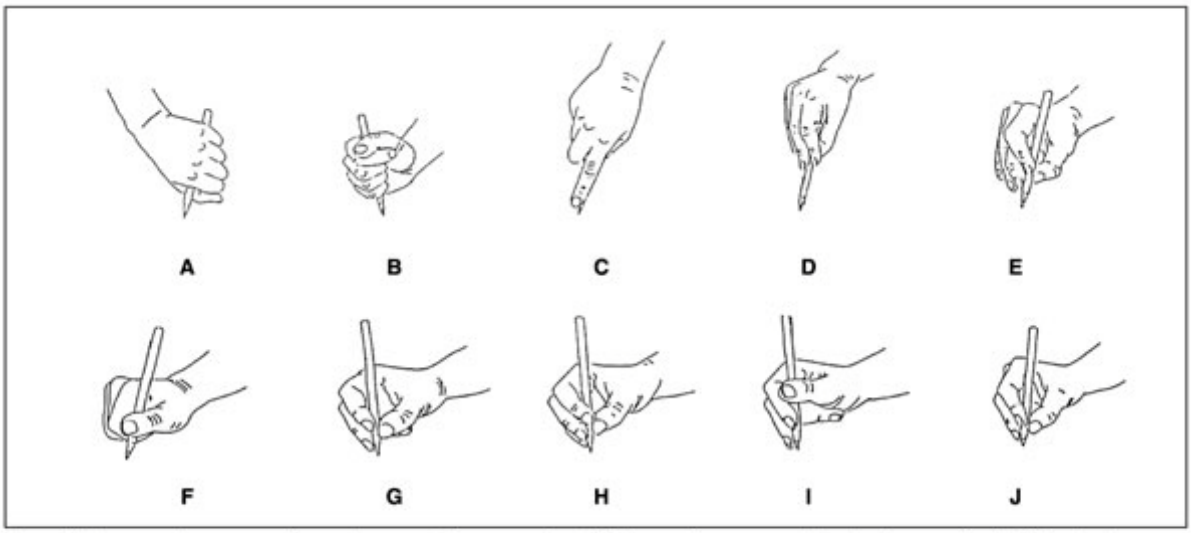
Factors mainly affectQuality and Speed of writing: [6]

1) Pen grippoSition
2) Strength and flexibility of muscle
3) Overall posture of the writer

In most of the languages handwriting is result of two primary movements vertical from fingers movements and horizontal from wrist movements and also rightward movement of forearm.[7]

There are many kinds of grips that are used by individuals. And all different types of grips have different sort of musclework.

Following are common types of grips which are usually seen:



A = radial cross palmar grasp; B = palmar supinate grasp; C = digital pronate grasp, only index finger extended; D = brush grasp, E = grasp with extended fingers; F = cross thumb grasp; G = static tripod grasp; H = four fingers grasp; I = lateral tripod grasp; J = dynamic tripod grasp.

Figure 2 - Pencil grip postures[16]

Dynamic tripod grip - This is the most common way to hold the writing instrument. This is where the thumb , index finger & middle finger grasp writing instrument ,so they function together.

Four fingers grasp- Pencil held with four fingers in opposition, wrist and finger movement, forearm positioned on table.

Radial cross palmar grasp- Pencil positioned across palm projecting radially, held with fisted hand, forearm fully pronated, full arm movement.

Palmar supinate grasp- Pencil positioned across palm projecting ulnarly, held with fisted hand, wrist slightly flexed and supinated away from mid position, full arm movement,

Digital pronate grasp- Only index finger ex- tended-Pencil held in palmar grasp with index finger extended along pencil toward tip, arm not supported on table, full arm movement.

Brush grasp - Pencil held with fingers, eraser end of pencil positioned against palm, hand pronated with wrist movement present, whole arm movement, forearm positioned in air.

Cross thumb grasp- Fingers fisted loosely into palm, pencil held against index finger with thumb crossed over pencil toward index finger, finger and wrist movement, forearm positioned on table.

Static tripod grasp- Pencil stabilized against radial side of third digit by thumb pulp with index pulp on top of shaft, thumb stabilized in full opposition, wrist slightly extended and hand moving as a unit, pencil resting in open web space, forearm resting on table.
The type of grip of an individual is matured and also difficult to modify after the 16years of age.
Difficulties with handwriting may affect child's academic success development of written language &social emotional well-being.[9]Writer's cramp is common problem that occurs when more force in the forearm is required to hold the pen without slipping & also to produce the force at pen tip needed to write.[8]In teenagers writing speed improves with physical maturity.
Average rate-
Girls: 14.7wpm
Boys: 13.8
Rate between 10-20 is considered normal for 15 year old.
Speed of 8wpm will almost be considered to be handicapped.

Need of study
Many students suffer from slow writing speed problem which often affects the functional performance because it prevents students from meeting the time constraints involved in school work.
Udo et al (2000) explained that the writer's cramp is due to increased muscle force required to produce at forearm level to hold the pen without slipping and also the force that is needed to produce at the tip of pen to write. So they had proposed that increasing the size of diameter of pen,area of gripping the pen and/or increasing friction coefficient between hand and pen may help to decrease the muscle load. [10] Which ultimately will help student to write better and without any discomfort.As handwriting speed is directly affected by the pen diameter , shape and type of grip student had, we felt the need to study its effects.
Hence the need of study is to check effect of the pen diameter and pen grip which may alter the speed of writing.

Aim of study
To study effect of pendiameter and pen grip on handwriting speed.
Objectives:
1) To check effect of pen diameter on handwriting speed.
2) To check the effect of pen grip on handwriting speed.

Hypothesis
Null hypothesis
1) Pen diameter does not have any effect on handwriting speed.
2) Pen grip does not have any effect on handwriting speed.

Alternative hypothesis
1) Diameter of pen has effect on handwriting speed.
2) Pen grip has effect on handwriting speed.

Methodology
Study setting:
Study including students from 8th to 10th grade from D. E. S.high school Pune.
Sample size: 60
Study duration: From July 2014 to Feb 2015
Study population: Students from 8th to 10th class from a high school, Pune

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Materials and tools

1) A stopwatch
2) Large diameter pen
3) Regular diameter pen
4) Papers
5) Data collection sheet
6) Paragraph to copy
7) Stopwatch
8) Informed consent

Figure 1: Regular diameter pen and large diameter pen

Criteria

Inclusion criteria

1) Students of 8th to 10th grade
2) Both the left and right hand dominants
3) Students using any type of grip
4) Students using any type of pen

Exclusion criteria

1) Student with learning difficulties
2) Surgery or trauma to the dominant hand
3) Paralysis of muscles of dominant hand
4) Recent trauma or fracture to dominant hand
5) Infections or burns to the dominant hand
6) Conditions such as tennis elbow, writers cramp

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Procedure:

Ethical clearance was taken from the ethical committee of the Institution.
Subjects were selected as per the inclusion and exclusion criteria.
Informed Consent was obtained from participants.
All the participants were given a paragraph of English language having the same content. Then they were instructed to copy the paragraph on A-4 sheet in one minute time. in the first trial they were asked to use their regular pen which they use daily for their school work. And after 5minutes of break, a large diameter pen was provided to them to copy the same paragraph in one minute. A stopwatch was used to record the time required by individual student to copy the paragraph. Every student was individually observed for the type of pen grip. Hand writing speed of all students was calculated as number of words per minute.(wpm)

Figure 3: Subject performing task with regular diameter pen

Figure 4: Subjectperforming task with large diameter pen

Results

The present project is "To study the Effect of pen diameter and pen grip on handwriting speed in high school students" . Students were given a paragraph in English to copy in a minute, first with regular diameter pen secondly with large diameter pen. In the study the handwriting speed was calculated by words per minute.

The statistical analysis was done using Instat software.

Age distribution

The average age of the selected students for this study was 13.08 years and the study population was homogenous.

Gender distribution

In the collected data of 60 students 40 were females and 20 were males (table no.1 graph no.1)

Hand writing speed

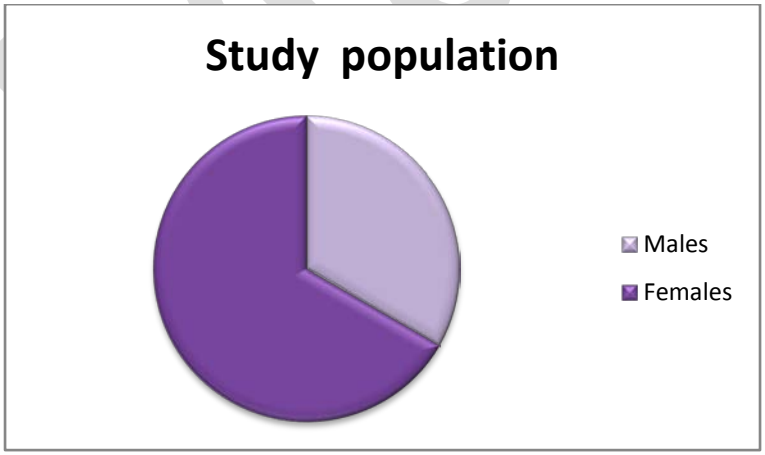
The average hand writing speed with large diameter pen was 25.76+/-3.264 and hand writing speed with regular diameter pen was 23.06+/-3.404. Paired t test was done to analyse the values. The T Value was t=15.415 and p <0.0001 , which is statistically significant. The results suggests that the pen diameter has an effect on handwriting speed. Writing with large diameter pen provides faster speed than that of the regular diameter pen. (table no.3 graph no.3)

Grip type

In the present study , two types of grip were used by the students which were tripod and quadropod. The paired t test was used to analyse the values. The average hand writing speed with tripod grip was 25+/-3.10 and with quadropod grip was 22+/-2.7. The T value was t=1.704 and p=0.0470. Which is statistically significant. The results shown that grip type has an effect on hand writing speed. Tripod grip provided faster hand writing speed than that of the quadropod grip.(table no.2 graph no.2)

Table 1: Gender distribution

	No of students	Percentage (%)
Female	40	66.66
Male	20	33.33
Total	60	



Graph 1: Gender distribution

Table 2: Pen grip distribution

Type of grip	No of students	Percentage (%)
Tripod	50	83.33
Quadrupod	10	16.66
Total	60	

Graph 2: Pen grip distribution

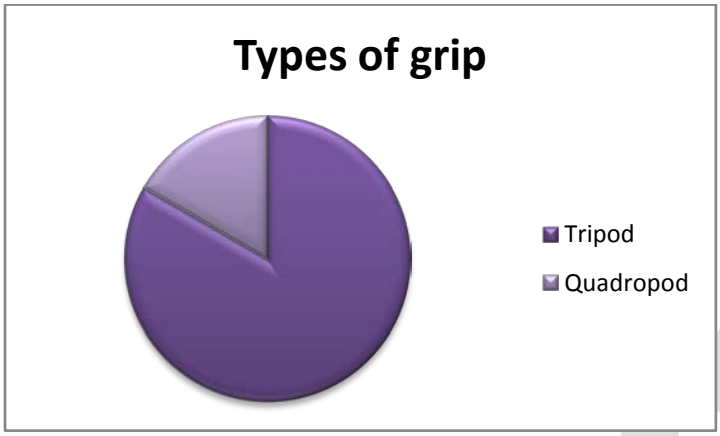


Table no: 3

Diameter of pen	Hand writing speed Mean with standard deviation	t value	P value
Regular diameter(3mm)	23.06+/-3.404	15.415	<0.0001
Large diameter(10mm)	25.76+/-3.264		

Graph 3: comparison of hand writing speed with large diameter pen and regular diameter pen

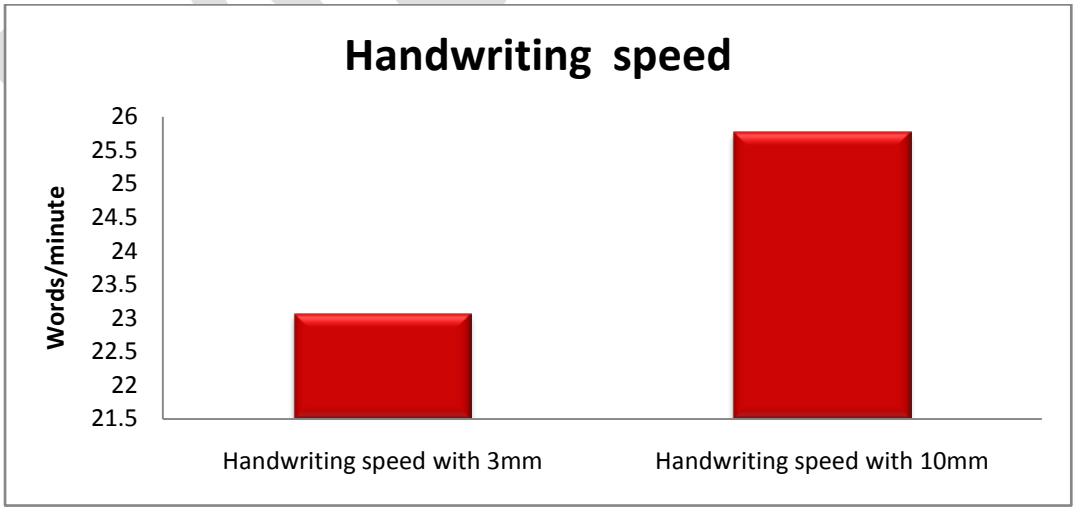
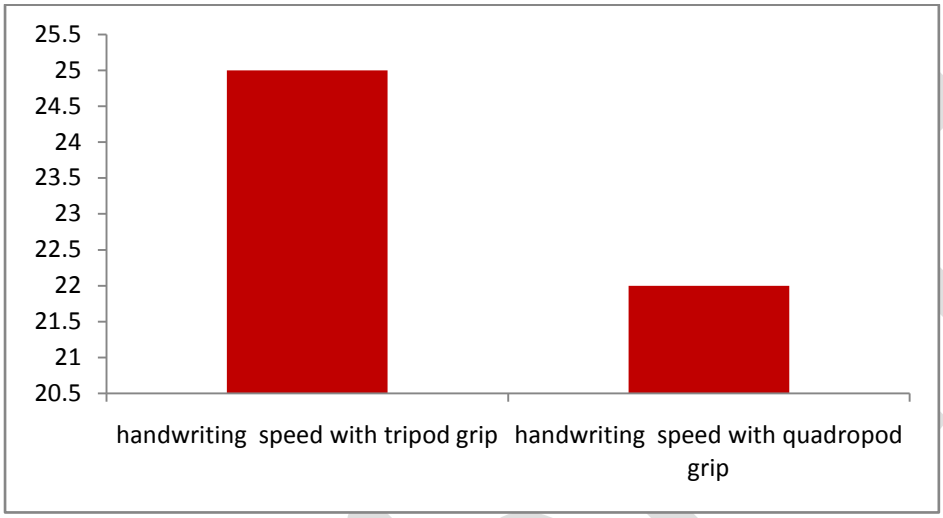


Table no: 4

Type of pen grip	Hand writing speed Mean with Standard deviation(wpm)	T value	p value
Tripod grip	25+/-3.10	1.704	0.0470
Quadropod grip	22+/-2.7		

Graph 4: Comparison between tripod and quadropod grip



Discussion

The present project was conducted to study the effect of pen diameter and pen grip on handwriting speed of high school students. The students were given a paragraph to copy first with their regular pen (3mm diameter) and secondly with large diameter pen (10mm) in a minute respectively. The outcome measure was handwriting speed which was calculated as words per minute . The result from statistical analysis of the present study supported hypothesis which stated that pen diameter and pen grip has an effect on handwriting speed. Further it was found that large diameter pen had faster handwriting speed as compared to regular diameter pen & the writing speed with tripod grip was faster with quadropod grip.

In the present study the averge age of selected students was 13+/-0.28.

In the present study out of 60 students 40 were females and 20 were males.

The average hand writing speed with regular diameter pen was 23.06+/-3.404. The average hand writing speed with large diameter pen was 25.76+/-3.264. Paired t test was done to analyse the values. Hand writing speed with large diameter pen was faster than regular diameter pen which was statistically significant.

The large diameter pen provides larger grip as compared to regular diameter pen which ultimately reduces the muscle work and muscle fatigue while gripping and writing. This could be the reason behind faster hand writing speed with large diameter pen. In a study conducted by Kao, he mentions that pen with larger diameter are preferred by students. In another study by Wu and Luo (2006) concludes that shape, length and diameter of touch pen affect the handwriting performance and also the efficiency. [11]

The average hand writing speed with tripod grip was 25+/-3.10 whereas hand writing speed with quadrupod grip was 22+/-2.7. The difference was statistically significant. The tripodgrip provides faster speed than that of quadrupodgrip.

This could be because of tripod grip requires less muscle work as compared to quadrupod grip hence reducing the muscle fatigue.
So training can be provided to the students with large diameter pen to improve hand writing speed and which will ultimately improve their performance in acaedemics. Graham et al showed that training could improve handwriting speed and legibility in grades 1-9 students.[9]

Conclusion

The handwriting speed with the large diameter pen was faster than regular diameter pen and the tripod grip showed faster writing speed than quadrupod grip.

References

1. Dennis, J. L., &Swinth, Y. (2001). Pencil grasp and children's handwriting legibility during different-length writing tasks. The American Journal of Occupational Therapy, 55(2), 175-183.
2. Heggannavar, A., &Chitroda, J. Effect of Upper Limb Exercises on Handwriting Speed with different diameters of pen. SPORT SCIENCES, 27.
3. Tseng, M. H., & Chow, S. M. (2000). Perceptual-motor function of school-age children with slow handwriting speed. The American Journal of Occupational Therapy, 54(1), 83-88
4. Kapandji, physiology of joints upper limb volume 1, 5th edition
5. Koppenhaver, K. M. (2007). Factors that cause changes in Handwriting. Forensic Document Examination: Principles and Practice, 27-36.
6. Alston, J. (1995). Lockwood, M. (1994). Assessing and promoting writing skills Jean Alston Stafford: NASEN Enterprises, 1993. 79pp. Child Language Teaching and Therapy, 10(2), 228-229.
7. Goonetilleke, R. S., Hoffmann, E. R., &Luximon, A. (2009). Effects of pen design on drawing and writing performance. Applied ergonomics, 40(2), 292-301.
8. Schneck, C. M., & Henderson, A. (1990). Descriptive analysis of the developmental progression of grip position for pencil and crayon control in nondysfunctional children. The American Journal of Occupational Therapy, 44(10), 893-900.
9. Graham, S., Berninger, V., Weintraub, N., & Schafer, W. (1998). Development of handwriting speed and legibility in grades 1–9. The Journal of Educational Research, 92(1), 42-52.
10. Mackay, N., McCluskey, A., & Mayes, R. (2010). The Log Handwriting Program improved children's writing legibility: A pretest–posttest study. The American journal of occupational therapy, 64(1), 30-36.
11. Daniel, M. E., & Froude, E. H. (1998). Reliability of occupational therapist and teacher evaluations of the handwriting quality of grade 5 and 6 primary school children. Australian Occupational Therapy Journal, 45(2), 48-58.
12. Baur, B., Schenk, T., Fürholzer, W., Scheuerecker, J., Marquardt, C., Kerkhoff, G., &Hermsdörfer, J. (2006). Modified pen grip in the treatment of writer's cramp. Human movement science, 25(4-5), 464-473.
13. Koziatek, S. M., & Powell, N. J. (2003). Pencil grips, legibility, and speed of fourth-graders' writing in cursive. The American journal of occupational therapy, 57(3), 284-288.