Journal of Criminology and Forensic Studies
ISSN: 2640-6578

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*Research Article* *Volume 6 Issue 1*

# Comparative Study of Handwriting Characteristics in Hindi Transcript Written on Different Surfaces: A Forensic Perspective

**Kehkashan H[1]* and Manohar YM[2]**

[1]Department of Forensic Science, School of Advanced Science, India
[2]Kalasalingam Academy of Research and Education, India

***Corresponding author:** Habeeb Kehkashan, Department of Forensic Science, School of Advanced Science, Kalasalingam Academy of Research and Education, LH-3 Kalasalingam Academy of Research and Education, Krishnankoil, Virudhunagar, Tamilnadu, PIN-626126, Tel: 08958247802; Email: kehkashanhabeeb@klu.ac.in

**Received Date:** October 30, 2024; **Published Date:** December 04, 2024

## Abstract

This work presents a comparative forensic analysis of handwriting characteristics in Hindi scripts written on various surfaces, with the objective of enhancing the precision and reliability of forensic document examination. The study explores the impact of different substrates, including paper, fabric, plastic, and glass, on distinctive handwriting features such as stroke formation, slant, pressure, and spacing. Through a combination of microscopic analysis, digital imaging techniques, and statistical assessment, the research investigates how the physical properties of these surfaces—such as texture, porosity, and reflectivity—affect the manifestation of handwriting characteristics. The results provide crucial insights for forensic experts, emphasizing the need to consider surface-dependent variations when analysing handwriting in diverse contexts. The findings contribute to the advancement of forensic document examination methodologies, offering a deeper understanding of the challenges associated with non-traditional writing surfaces and their implications for forensic investigations.

**Keywords:** Handwriting Characteristics; Hindi Script; Forensic Document Examination; Surface Variation; Handwriting Analysis; Non-Traditional Surfaces; Questioned Document Analysis

## Introduction

A "document" is something that containing marks, symbols or sign that convey meaning to someone. Documents are written on paper using a machine for typing, by hand, with pencil, pen, and ink, among many other materials that can be used for the same purpose. These materials and writing implements come together to generate the enormous archive of written records that every human being has used to document his deeds and ideas. Although information is now kept electronically, on wax, or on tapes, papers are often composed of paper, but written messages can also be found on boards, walls, floor tables, clothing, metal plates, and human bodies [1]. Any substance that has any markings, symbols, fingerprints, footprints, writing, signatures, or figures that are eventually conveyed to someone is referred to as a "document."

Kehkashan H and Manohar YM. Handwriting Characteristics; Hindi Script; Forensic Document Examination; Surface Variation; Handwriting Analysis; Non-Traditional Surfaces; Questioned Document Analysis. J Crim Forensic studies 2024, 6(1): 180078.

## Handwriting

Science can be characterised as an analytical and practical endeavour that entails the observation and experimentation of the structure and behaviour of the world. The process of handwriting inspection involves both practical (observing and recording findings) and intellectual (interpreting what is observed) elements. The method of examination is vast; rather than concentrating on individual characteristics, it is based on a comprehensive and full approach. The behaviour is covered by knowledge of people's writing abilities, and the pertinent structure is in handwriting (and an understanding of its physiological underpinnings). The corpus of public information that provides the experimental component is something that practitioners should also be aware of. Handwriting is a complex perceptual-motor act that is learned semiconscious and sometimes referred to as a neuromuscular task or activity. Brain writing is another name for handwriting. One of the most advanced feats of the human hand is the ability to write. It is a task that is performed in a smooth or continuous manner rather than in distinct or separate steps. With 27 bones and more than 40 muscles directing it, the hand is a very sophisticated and delicate machine. A complicated network of tendons connects the lower arm's majority of muscles, which are located there, to the fingers. Their capacity to wield a writing tool is precisely coordinated by a timing system that is neurologically controlled by the motions of the arm, hand and fingers. By carefully timing and arranging the motions, the pen or pencil may capture a pattern and accurately record its structure. The sequence of these motions establishes the habitual writing traits that are particular to each person. According to a writer's writing habits tend to become more automatic with time [2]. Writing like painting, dancing or cycling is a learned skill. The early stages of learning and practicing writing are marked by a conscious attempt on the part of the student to imitate standard letter shapes. They begin by forming a mental image of the model in front of him and attempting to translate it into writing using his hand muscles. After some practice, proficiency is gained and the writing becomes more established and mature. It is no longer a conscious effort but rather a reflex motion. There are numerous elements that can influence an individual's handwriting development as well as the conditions in which handwriting is reached. Conditions in which handwriting is attained also play a role and can lead to changes in an adult's handwriting. There are numerous aspects that have an effect on handwriting in a discontinuous situation. Unusual writing devices are used to write on common surfaces such as walls, windows, mirrors, balloons, clothing, skin, floor and furniture. These are the circumstances that can cause handwriting differences.

**The Writing Positions:** It appeared that writing in various positions such as standing, walking, travelling and in odd conditions was distorting. The writing was done in an unorganised environment. The writer on the other hand was carrying a large load of tools. And the writing was discovered when a duplicate of a standard sample was taken in the same conditions and a significant connection was discovered.

**The Writing Surface:** In several cases on an odd surface evidence was found. The writing surface can also affect how something is written. Large copper tubes with sturdy metal surfaces were tested for writing based on some, if ambiguous evidence suggesting a connection between the lettering and the original writers. Throughout the evaluation a number of factors were taken into account including the pipe's curvature and the impact of the writing tool on the movement of the flesh.

**The Writing Instrument:** When a writer's writing instrument has an impact on their work, it is rarely very valuable. The person used a variety of writing instruments, and there was a discernible variance in their writing due to their comfort level and choice of particular instrument, or the influence of the instrument.

## Unusual Writing Surfaces

Documents written on strange writing surfaces with unique writing devices. Suicides frequently include the employment of unique writing utensils and strange writing surfaces. Most of the time, suicide notes that were written by the victim just before the act are obtained by detectives and help with the inquiry. Frequently found with suicide notes are mirrors, beds, sheets, walls, tables, doors, metals, shoes, skin balloons, and other writing surfaces. It has been demonstrated that the ideal surface for leaving messages is skin. Because there is enough space and it could be challenging to engrave on the skin's surface, skin messages are printed on paper. Skin has been found to be the best surface for leaving messages because of its easy accessibility and resilience to damage. Skin messages on paper are caused, among other things, by its pigmentation, flexibility, suppleness, and hair density. Research on suicide notes written on skin and suicide messages written on the stomach of the deceased has led to the conclusion that a writer's typical handwriting is unaffected by the surface on which it is written [3,4]. There is a case report of a victim who had a suicide note written in the same ball point ink and covered in smudged and un smudged marks on her palms by the pen. An incident where the victim had his handwriting etched on his body was documented, and it was found that the writing on his body had interfered with the letter structures. Skin surface influences handwriting peculiarities that could aid the investigator in determining the authorship of writing found on the skin because a number of internal and external factors, including position, handedness, types of instruments used, time, and

other factors, are significant [5]. These studies were based on Handwriting and handwriting samples analysed with the help of Stereomicroscope and magnifying glass. To ascertain how the properties of handwriting on paper, skin and cloth had changed the handwriting sample was evaluated and compared. The potential for variance in analysis the slant, line quality, speed, pen pressure, letter size, spacing on different surfaces and compare the questioned sample with standard. In India Hindi is the mother tongue because of this almost suicide notes in suicide cases found in Hindi language and also in regional language. Suicide notes in comparison to natural writing of victims are thought to show a high degree of natural variety due to the vast range of emotions. The unusual surfaces also give the natural variation in handwriting [6].

## Materials and Methodology

### Sample Collection

For this study, 300 handwriting samples were collected from 100 individual writers, and three handwritten samples were collected from each writer on three unusual surfaces, such as paper, cotton cloth (white handkerchief) and skin, with one writing instrument, a black ball pen. The writer belongs to the age group of 18–30 years [7-12]. All of them had good writing skills in Hindi. They were asked to fill a consent form and give their basic details like gender, age, illness and handedness. The Hindi text containing 2 lines with the repetition of some words 3-4 times were Written on three unusual surfaces such as paper, cloth and skin with a black ball pen in all samples with natural handwriting and in each of them was requested to write the same sentence on paper, cotton cloth and the skin surface of their forearm.

"आपको हमेशा खुद पर वशि्वास करना है और अपने आत्म वशि्वास को कम नहीं होने देना है"

Due to the humid conditions, the sample writing on the skin surface of the forearm was instantly photographed using a smart phone (Vivo V21). The ink from a ball pen was unable to attach to the surface because its oily components were rejecting the moisture [13-22]. Give each writer the opportunity to first complete the three samples in their native handwriting on three different surfaces (paper, cotton cloth and forearm skin), with given pen and give the name S1, S2.....S100. After taking sample on all the three surfaces (paper, cotton clothes (white handkerchief) skin), with given black ball pen, instantly photographed with smart Phone (Vivo V21). After taking all the samples (S1, S2, S3....S100), all over 300 samples, were examined based on their class and individual characteristics such as slant, line quality, pen pressure, speed, spacing and letter size, with the help of a stereomicroscope and magnifying glass. Because of unusual surfaces such as paper, cotton cloth (white handkerchief) and skin, there was variation in class and individual characteristics (Figures 1-3).

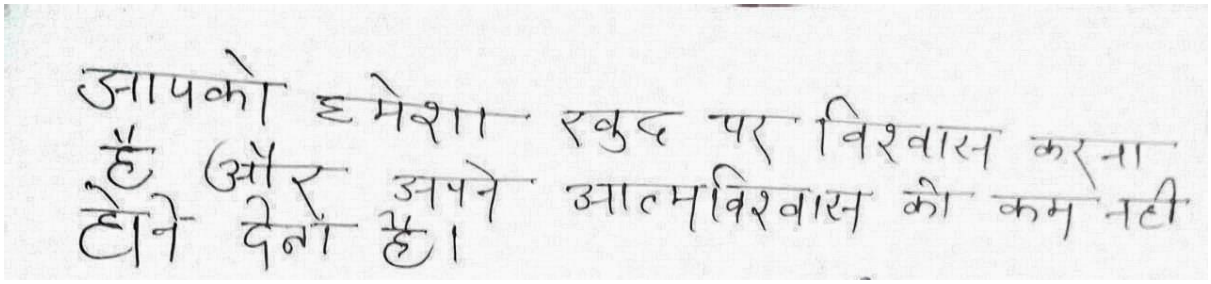


**Figure 1:** Content written on paper

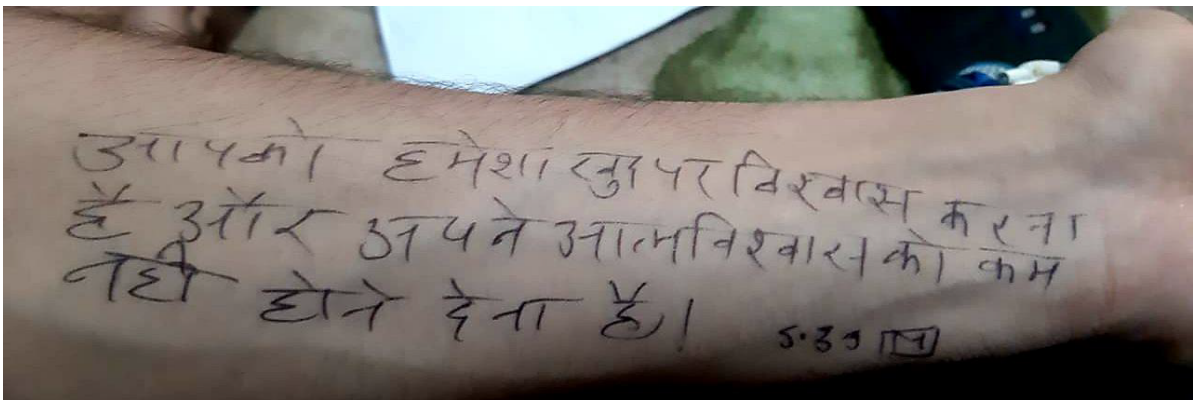


**Figure 2:** Content written on skin

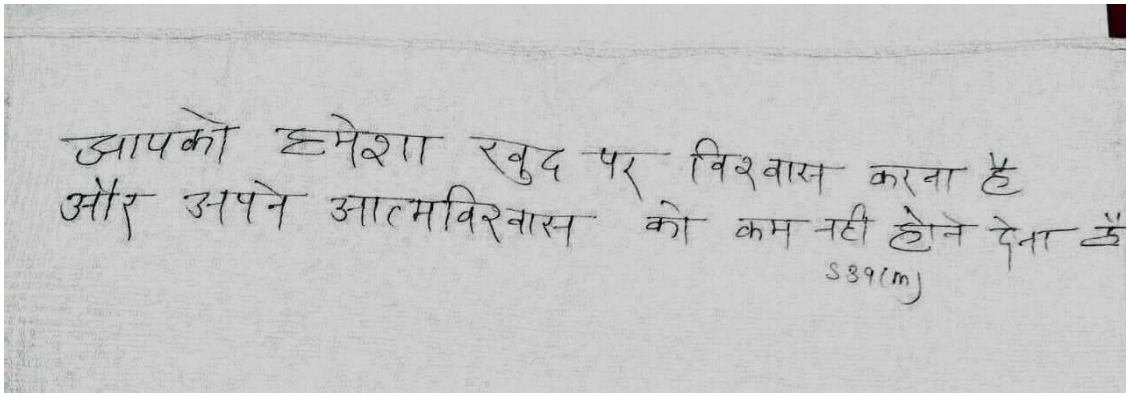


**Figure 3:** Content written on cloth

## The Parameters Measured

**Slant:** Letter's axis angle or inclination with respect to the baseline is referred to as slant in writing. The subject changes depending on the writer. While it is true that a decrease relative to the baseline occurs when a slant changes to something more pronounced, only when compared to the baseline's perpendicular vertical, which is where it increases. Types of slant: slants are seven types: Vertical, Straight, Ascending, Descending, Irregular, down ward.

**Spacing:** In order to ensure uniform letter spacing, writers are instructed to use connecting strokes of the same size. In order to prevent the intertwining of upper and lower loops, writers are instructed to space their letters essentially on a horizontal plane. The parameters of the writing have an impact on how a writer uses space. Types of spacing: wide and narrow.

**Line Quality:** In any discussion of handwriting express line quality, while this term is difficult to define its meaning may be made clear by considering how a handwriting which can be said to exhibit good line quality differs from that of poor line quality. Types of line quality: Good, Poor, Gradual, Abrupt.

**Pen Pressure:** Heavy pressure can be graduated, impulsive or uniform and it makes people write more slowly and leaves indentations in their lines. Comparatively smoother and more rhythmic than writers who apply pressure to their writing are those who write very light. Type of pen pressure: heavy, Medium, Light.

**Letter Size:** Heavy pressure cursive can have graduated, impulsive or uniform length, width and size. This type of cursive slows down writing and leaves indentations in the lines. Those who write very light are comparable to smoother and more rhythmic than writers who apply pressure. As time goes on a writer's various letters and words take on fixed personal characteristics. The ratio of the letter or word's length to its width is taken into account in this situation because the size of handwriting may vary depending on the available space and content. Types of Letter size: Large, Medium, Small.

**Speed:** speed are based on three types: High, normal, slow In this study 7 Hindi words taking from samples for analysis. These words were repeated in the entire Hindi text 3-4 times. The words were:-
"आपको हमेशा खुद पर वश्विास करना है और अपने आत्म वश्विास को कम नहीं होने देना है"
अ, ह, क, न , म , प , र

In this paragraph, the word अ, ह, क were repeated 4 times and the word न was repeated 5 times and the word प म र were repeated 3 time in all samples, whereas each word was repeated 2 times in all samples. Skin samples photographed and then analyzed in stereomicroscope and with magnifying glass. The paper and cotton cloth (white handkerchief) samples also analyzed by stereo microscope and magnifying glass. Each writer's handwriting was examined individually to determine the deviation on different writing surfaces and focus on the changes that occur in characteristics due to natural variation and compare the variation in handwriting due to unusual surfaces.

## Statistical Analysis

After taking photograph of samples different parameters were taken such as slant, line quality, pen pressure, spacing, speed, letter size was analysed statistically by using chi square test.

## Comparison

After statistical analysis comparing the handwriting samples on three different unusual surfaces such as Paper, cloth, Skin

and finding out the variation in handwriting due to surfaces.

## Results

Different parameters taking like Slant, Line quality, speed, spacing, letter size, pen pressure is analysed in all samples by stereomicroscope and magnifying glass and show variation in handwriting due to different unusual surfaces (paper, cloth, skin) (Tables 1-3).

| Parameter | Sample on Paper | Sample on Cloth | Sample on Skin |
|---|---|---|---|
| 1. Slant | | | |
| (a) Ascending | 7 | 14 | 22 |
| (b) Descending | 13 | 8 | 18 |
| (c) Vertical | 11 | 24 | 0 |
| (d) Irregular | 17 | 11 | 34 |
| (e) Straight | 50 | 42 | 22 |
| (f) Down word | 2 | 1 | 4 |
| **2. Line quality** | | | |
| (a) Poor | 33 | 45 | 74 |
| (b)Good | 53 | 46 | 18 |
| (c) Gradual | 11 | 8 | 4 |
| (d) Abrupt | 3 | 1 | 4 |
| **3. Spacing** | | | |
| (a) Narrow | 75 | 64 | 88 |
| (b)Wide | 25 | 36 | 12 |
| **4. Pen Pressure** | | | |
| (a) Heavy | 67 | 11 | 2 |
| (b)Medium | 29 | 64 | 59 |
| (c) Low | 4 | 25 | 39 |
| **5. Speed** | | | |
| (a)High | 24 | 17 | 26 |
| (b)Normal | 63 | 69 | 62 |
| (c)Low | 13 | 14 | 12 |
| **6. Letter Size** | | | |
| (a)Large | 16 | 28 | 25 |
| (b)Medium | 37 | 31 | 49 |
| (c)Small | 47 | 41 | 26 |
| Total | 100 | 100 | 100 |

**Table 1:** Explain the writing transcribed on paper, cloth and skin were examined in all samples and variation found in all sample due to unusual surfaces.

| | Slant | Line quality | Spacing | Pen pressure | Speed | Letter size |
|---|---|---|---|---|---|---|
| Paper | Ascending (7) | Poor (33) | Narrow (75) | Heavy (67) | High (24) | Large (16) |
| | Descendin | Good | Wide | Medium | Normal | Medium |
| | g (13) | 53 | 25 | 29 | 63 | 37 |
| | Vertical (11) | Gradual (11) | | Light (4) | Slow (13) | Small (47) |
| | Straight (50) | Abrupt (2) | | | | |
| | Down word (2) | | | | | |
| | Irregular (17) | | | | | |
| Cloth | Ascending (14) | Poor (45) | Narrow (64) | Heavy (11) | High (17) | Large (28) |
| | Descendin g (8) | Good (46) | Wide (36) | Medium (64) | Normal (69) | Medium (31) |
| | Vertical (24) | Gradual (46) | | Light (25) | Slow (14) | Small (41) |
| | Straight (42) | Abrupt (1) | | | | |
| | Irregular (11) | | | | | |
| | Down word (2) | | | | | |
| Skin | Ascending (22) | Poor (74) | Narrow (88) | Heavy (2) | High (26) | Large (25) |
| | Descendin g (18) | Good (18) | Wide (12) | Medium (59) | Normal (62) | Medium (49) |
| | Straight (22) | Gradual (4) | | Light (39) | Slow (12) | Small (26) |
| | Irregular | Abrupt | | | | |
| | 34 | 4 | | | | |
| | Down ward (4) | | | | | |

**Table 2:** Explain the comparison of handwriting samples and the differences occurs in handwriting due surfaces (paper, cloth, skin).

| Parameter | Paper +Cloth+ Skin | Paper +Skin | Paper+ Cloth | Cloth +Skin |
|---|---|---|---|---|
| Slant | 12 | 12 | 36 | 19 |
| Line quality | 27 | 11 | 36 | 22 |
| Spacing | 59 | 14 | 20 | 6 |
| Speed | 51 | 9 | 17 | 12 |
| Letter size | 44 | 20 | 24 | 7 |
| Dissimilar | | | | |
| Parameter | Paper+ Cloth+ Skin | Skin | Paper | Cloth |
| Slant | 23 | 36 | 17 | 10 |
| Line quality | 3 | 31 | 14 | 10 |
| Spacing | 0 | 19 | 7 | 10 |
| Pen pressure | 14 | 20 | 50 | 5 |
| Speed | 1 | 23 | 12 | 8 |
| Letter size | 1 | 25 | 8 | 19 |

**Table 3:** Explain the similarity and dissimilarity of handwriting parameters and some parameters found similar and some dissimilar due unusual surfaces (paper, cloth, skin).

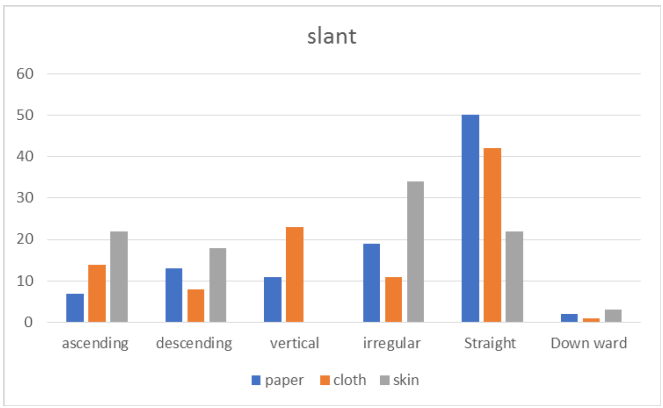


**Figure 4:** Variation in slant on different surfaces (paper, cloth, skin).

Figure 4 Shows variation in slant on different surfaces such as paper, cloth and skin, in slant six feature (ascending, descending , vertical, irregular, straight, down ward) are analysed and straight shows highest peak on paper ,cloth and in other irregular shows highest peak on skin. Similarly, down ward show lowest peak on paper, cloth, skin.

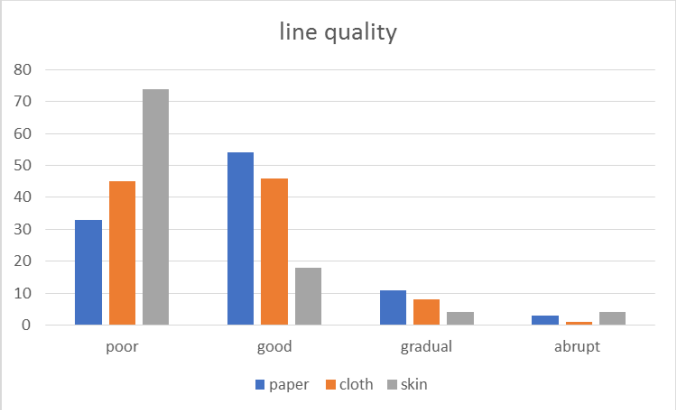


**Figure 5:** Variation in line quality on different surfaces.

Figure 5 Shows variation in line quality on different surfaces such as paper, cloth and skin, in line quality four feature (poor, good, gradual, abrupt) are analysed and poor shows highest peak on skin and good shows highest peak on paper, cloth. Similarly, abrupt show lowest peak on paper, cloth and skin.

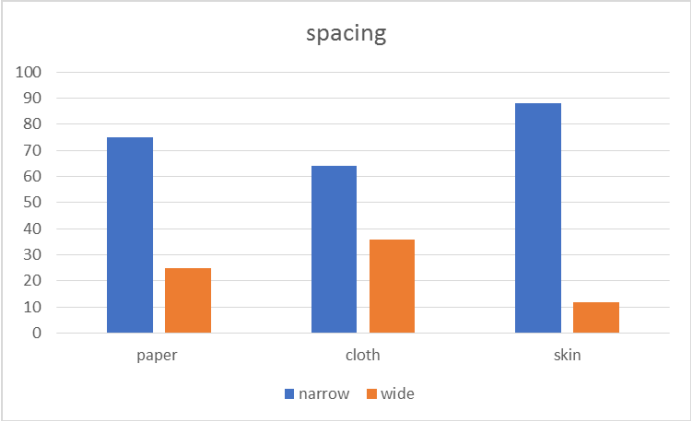


**Figure 6:** Variation in spacing on different surfaces.

Figure 6 Shows variation in Spacing on different surfaces such as paper, cloth and skin, in Spacing two features (narrow and wide) are analysed and narrow shows highest peak on skin, paper and cloth. Similarly, wide shows lowest peak on skin then cloth and paper.

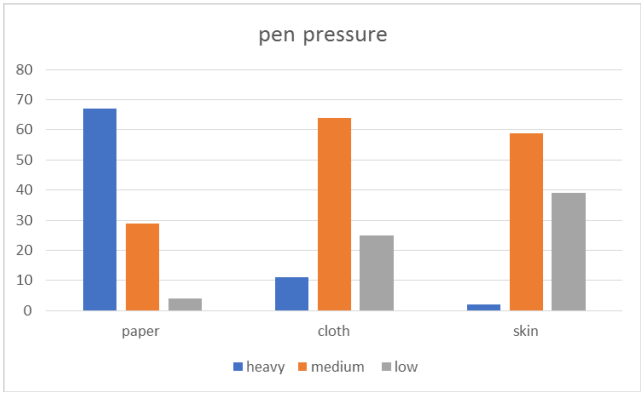


**Figure 7:** Variation in pen pressure on different surfaces.

Figure 7 Shows variation in Pen pressure on different surfaces such as paper, cloth and skin, in Pen pressure three features (heavy, medium and Low) are analysed and heavy shows highest peak on paper and medium shows highest peak on cloth and skin. Similarly, Low shows highest peak on skin then cloth and paper.

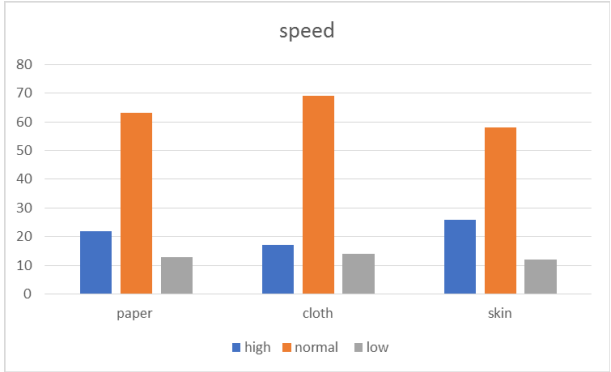


**Figure 8:** Variation in speed on different surfaces.

Figure 8 Shows variation in Speed on different surfaces such as paper, cloth and skin, in Speed three features (high, Normal and Low ) are analysed and normal shows highest peak on cloth, paper and skin .And high shows highest peak on skin, paper and cloth. Similarly Low shows highest peak on cloth, paper and skin.

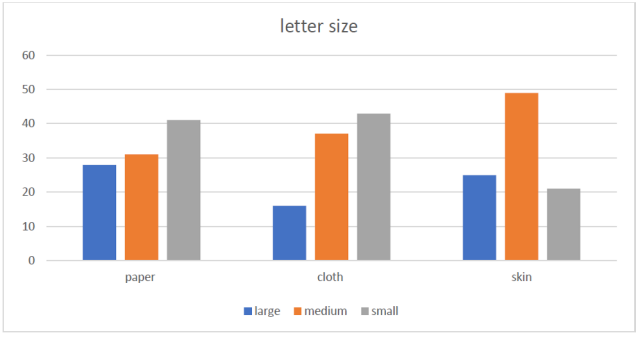


**Figure 9:** Variation in letter size on different surfaces.

Figure 9 Shows variation in letter size on different surfaces such as paper, cloth and skin, in Letter size three features (Large, Medium and Small) are analysed and medium shows highest peak on skin, cloth and paper, Small shows highest peak on Cloth, paper and skin. Similarly, Large shows highest peak on cloth, paper and skin.

## Discussion

In this study 300 handwritten samples are collected from 100 skilled writers out of which 50 are males and 50 are females. All of them had good writing skills in Hindi, request to each writer write the same sentence on three different surfaces like paper, cloth (white handkerchief) and skin.

"आपको हमेशा खुद पर वशि्वास करना है और अपने आत्म वशि्वास को कम नहीं होने देना है"

To determine the impact of unusual surfaces on the samples, Hindi writing is applied to all samples and the skin sample is immediately photographed using a smartphone (Vivo V21). This photograph is then compared to the writing that a present on the same person's paper and cloth. The most frequent causes of writing on skin surfaces are feature abnormalities, Elasticity, inconsistency, coloration, hair density and most crucially, unique handwriting traits, skin's suppleness, unevenness, pigmentation, hair density are most significantly. It is well known that ball point pens are made to write on regular paper and similarly the surface of paper is furnished throughout the production process to allow for the free movement of writing instruments. There are hesitation lines and alignment variations when a ballpoint pen is used to write over clothes. When a ballpoint pen is used to write on a soft cushiony surface of skin, it gives the writing a palpable quality and gives it a new visual quality [23-29].

These interruptions are most likely caused by the unpleasant posture the soft and cushiony quality of the skin tissues, the suppleness of the skin, the density of hair across the area and the uneven engagement of the ball pen with the skin surfaces. The simplification seems to have reduced the region that is bounded by the क oval, न bulb, and क hemp. The parameter such as Slant, line quality, Speed, Spacing, pen pressure, Letter size are analysed by stereomicroscope and magnifying glass in all samples and parameter are compared on three surfaces and find out the variation in handwriting. The chi square value of the parameter except the spacing all are found not significant, on three surfaces such as paper, cloth, skin. On the basis of above observation some samples found significant and some not significant in all samples by using chi square test.

## Conclusion

The study sought to investigate how various surfaces paper, fabric and skin—affect the features of Hindi handwriting. A total of 300 samples are collected from 100 skilled writers, equally divided between males and females, who wrote the same sentence on each surface. The analysis revealed that writing on skin, in particular, presented unique challenges due to the surface's elasticity, unevenness, and hair density, which led to noticeable variations in handwriting. While parameters such as slant, line quality, speed, pen pressure and letter size are examined, only spacing showed significant differences across the three surfaces [30-39]. The chi-square test further indicated that most of the handwriting parameters did not show statistically significant differences between surfaces, although some individual samples exhibited notable variations. These findings underscore the complexity of handwriting analysis on non-traditional surfaces and the need for careful consideration of surface characteristics in forensic examinations.

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