



Analysis of Dermatoglyphic Features: Comparison of the Ink, Lipstick and Improvise Digital Methods

Loveday Ese Oghenemavwe^{1*} and Odigwe Gloria²

¹*Biological Anthropology Unit, Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Nigeria.*

²*Department of Biomedical Technology, School of Science Laboratory Technology, University of Port Harcourt, Nigeria.*

Authors' contributions

This work was carried out in collaboration between both authors. Author LEO designed the study, performed the statistical analysis and wrote the protocol, while author OG wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The aim of the study was to compare the Ink, Lipstick and the Improvise Digital Methods by quantitatively and qualitatively analyzing some dermatoglyphic features of the digit and palm. Twenty one Biomedical Technology students were recruited for the study. The prints of the digits and palms of all participants were taken using the ink, lipstick and Improvise digital methods. In addition all participants were also trained to take the prints using all the methods and analyzed dermatoglyphic features. Dermatoglyphic parameters evaluated were digit patterns, total finger ridge count (TFRC) and ATD angles. In addition direct one-on-one interview method to measure participants' response to each of the methods was done. Chi-square test and paired t-test was used to analyze the results. There was no significant difference ($P > .05$) in the qualitative results for digit patterns obtained by the Improvise digital method with either of the other two methods. But qualitative evaluation of ATD angle and TFRC showed a statistical difference ($P = 0.00$ and $P = 0.01$). The Improvise digital method was rated 94.74% on participants' preference scale, 91.22% on ease of method and 94.74% on convenience. All the methods have their comparative advantages but the Improvise digital method was most preferred by participants.

*Corresponding author: Email: loveday.oghenemavwe@uniport.edu.ng;

Keywords: Dermatoglyphics; technology; accuracy; ATD angles; TFRC; lipstick; ink; digital.

1. INTRODUCTION

Dermatoglyphics refers to the study of the epidermal ridges patterns in the palm, sole, fingers, toes and lips [1-2]. It is applied in variety of disciplines such as population studies, medical anthropology, forensic science and genetic studies to answer several biological questions because of its genetic origin and uniqueness to individuals. [3-15]. Dermatoglyphics patterns are reported to be markers for certain genetic disorders like Down's syndrome [16,17], autism, [18] and skeletal malformations such as polydactyly [3]. It is also useful in psychiatry [19] and in the diagnosis of Schizophrenia and other medical conditions such as cardiovascular diseases, diabetes mellitus type II, epilepsy, hypertension [20-23], Kanner's syndrome [22, 24], hypoparathyroidism, [3,25,26], Klinefelter's syndrome [27] as well as in dentistry [28-32]. Currently, there are several methods of studying dermatoglyphics. They include the ink method [1, 15], lipstick method [33-35] and digital methods. The ink was described by Cummin and Mildo [1], although inexpensive, problem associated with the methods are well documented. [33]. The uses of hi-tech digital methods are on the increase; however due to lack of finance, facilities and expertise most researchers in the developing countries still use the ink method. Recently, Oghenemavwe and Osaat [36] described an Improvise digital method that can be performed using basic office scanner and computer. The aim of the study is to do a comparative analysis of the Improvise digital method, ink method and lipstick methods with respect to clarity of digital and palmer prints and user friendliness.

2. MATERIALS AND METHODS

2.1 Research Design

This study was both descriptive and analytical, involving a sample size of 21 students (10 males, 11 females) of Biomedical Technology of the University of Port Harcourt. Age was not a criterion for selection, as finger and hand print patterns are not altered with age.

2.2 Samples and Sampling Technique

The volunteers were students of Biomedical Technology Department of the University of Port Harcourt and they were selected using convenience sampling technique. All those

selected had no hand deformity. Each participant had their finger and palm prints taken by the three methods; the Ink method, the Lipstick method and improvise digital method. Before and after each procedure, participants washed their hands with soap and water and have them thoroughly dry with a clean lintless rag to remove any form of dirt or oil which might interfere with the collection of the prints. They also washed their hands after each procedure and wipe off any remaining stain with an absorbent wipe.

2.3 Procedure

The first method to be used was the Improvise digital method, followed by the Lipstick method and finally, the ink method. The rationale behind this sequence is to eliminate effect of colour obscuring the finger and palm ridges. In the digital method, no ink or color is used and the lipstick is easier to clean off than the ink.

2.3.1 Digital method

The procedure for the Improvise digital method is as described by Oghenemavwe and Osaat [36] using Hp G3110 Scanjet Scanner (9000x4800 dpi resolution) and laptop with Autocad Software. Before scanning begins, participants were asked to fill in their details such as gender and assigned identification number in the bio data form. After thoroughly washing and drying their hands, they were asked to place their palm on the scanner. Care was taken to ensure all the digits are properly aligned, including the flexor ridges of the wrist. Where this is not possible, the scan of the palm and digits were taken separately. The digital and palmar scans were qualitatively and quantitatively analyzed with the aid of Autocad software. (see Figs. 1a and 1b).

2.3.2 Lipstick method

The Lipstick method used is as described by Gupta and Gupta [33]. The subject's palms were thoroughly and carefully stained with lipstick. The colors used were red and black. Care was taken to ensure the hollow of the palms and the flexor ridges of the wrist were thoroughly stained too. The stained hands were then placed on the A4 bond papers from the proximal to distal end. The hand was gently pressed between intermetacarpal grooves at the root of fingers and the dorsal side corresponding to the thenar and hypothenar regions. The palm was then lifted from the paper in reverse order from distal to

proximal end. Then the hands were washed thoroughly and dried.

2.3.3 Ink method

The procedure for the Ink method is as described by Cummins and Midlo [1,15]. The ink was spread on the roller and the subject's palm was rolled over the roller until it was evenly smeared on the hands, hollow of the palms and the flexor

ridges of the wrist. The stained hands were then placed on the A4 bond papers from the proximal to distal end. The hand was gently pressed between intermetacarpal grooves at the root of fingers and the dorsal side corresponding to the thenar and hypothenar regions. The palm was then lifted from the paper in reverse order from distal to proximal end. Afterwards, subjects washed their hands with soap and water and wiped clean with rag.

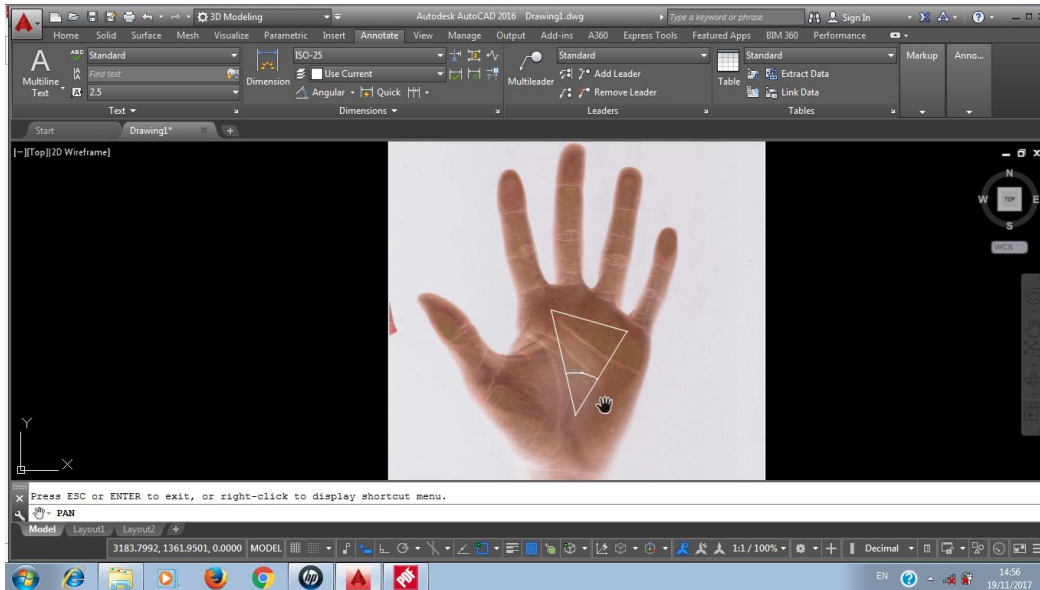


Fig. 1a. Scanned hand prints using the improvise digital method

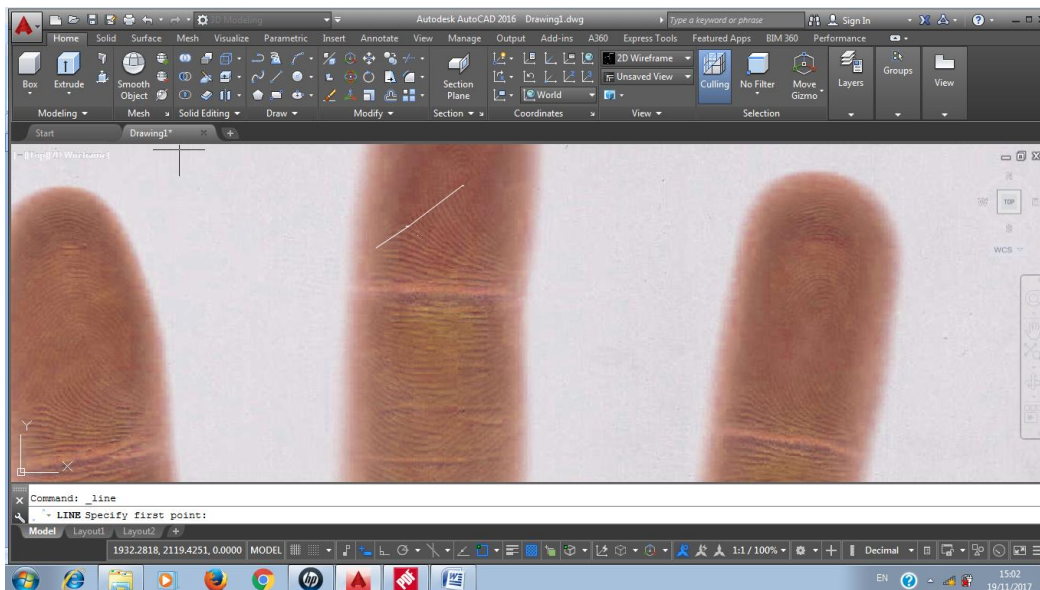


Fig. 1b. Scanned digit prints using the improvise digital method



Fig. 2. Palmar print using the lipstick method

2.4 Dermatoglyphic Analysis

2.4.1 Palmar pattern identification

The parameters measured were the digit patterns namely plain arch (PA), tented arch (TA), ulnar loop (UL), spiral whorl (SW), plain whorl (PW), double loop (DL) and central pocket whorl (CPW), total finger ridge count (TFRC) and ATD angles. The ATD angle is angle formed at triradius 't' by lines drawn between it and triradi 'a' and 'd'. (see Fig. 3). TFRC is the sum of all the ridge count for the 10 fingers. The ridge count is done by drawing a line from the triradius to the center of the pattern and determining the number of intersected ridges between the two points.

2.4.2 Statistical procedures

The data obtained were analyzed using SPSS (Statistical Procedure for Social Sciences ver. 18.0) computer software at $P = .05$ level of significance.

3. RESULTS AND DISCUSSION

The study has done a comparative analysis of the three different methods for the study of dermatoglyphics. Table 1 shows the combined result for the digit patterns present in both sexes while Tables 2 and 3 are the result for male and female participants respectively. The dermal ridge patterns present were plain arch (PA),

tented arch (TA), ulnar loop (UL), spiral whorl (SW), plain whorl (PW), double loop (DL) and central pocket whorl (CPW). The predominant pattern in most of the digits is ulnar loop. There was no statistical difference in the pattern occurrence for all fingers when the result from the Improvised digital method was compared with the ink and lipstick methods.



Fig. 3. Palmar prints using the ink method

The combined results for ATD angles and TFRC in both sexes are presented in Tables 4 while Tables 5 and 6 have the result for each of the sexes. Using the student t-test, there were differences in these parameters when the results obtained from using the Improvised digital method was compared with those from both the ink and lipstick methods.

In Fig. 4 is the graphical presentation of results for student rating of the three methods based on ease, preference, and convenience and user friendliness. Participants rated the Improvised methods better in all measured parameters.

This study has done a comparative analysis of the ink, lipstick and Improvised digital methods for the evaluation of dermatoglyphics features of the digits and palms. Dermatoglyphics is such a broad field of study with a widespread scope of application and as such requires the most accurate and scientifically competent method for sample collection, analysis as well as a method that poses the least stress and health risk to the research participants, the researcher and the environment. The ink method invented by Cummins and Mildow [1,15] has been widely used as the conventional method even till date in resource limited countries. It has the problem of inconveniencing participant and over inking that

Table 1. Percentage frequencies of digit patterns and Chi-square test to determine if differences exist between digital and other methods (both sex)

Finger	Method	CPW	DL	PA	PW	SW	UL	TA	Chi-square analysis	
									X ²	P-value
Digital vs Ink										
LI	Digital	1 (4.8)	1 (4.8)	6 (28.6)	4 (19.0)	4 (19.0)	5 (23.8)	-	0.83	0.97
	Ink	1 (4.8)	1 (4.8)	7 (33.3)	2 (9.5)	4 (19.0)	6 (28.6)	-		
LII	Digital	3 (14.3)	1 (4.8)	2 (9.5)	2 (9.5)	0 (0.0)	10 (47.6)	3 (14.3)	1.2	0.98
	Ink	2 (9.5)	1 (4.8)	2 (9.5)	2 (9.5)	1 (4.8)	10 (47.6)	3 (14.3)		
LIII	Digital	4 (19.0)	1 (4.8)	1 (4.8)	-	1 (4.8)	13 (61.9)	1 (4.8)	2.44	0.78
	Ink	5 (23.8)	1 (4.8)	2 (9.5)	-	0 (0.0)	13 (61.9)	0 (0.0)		
LIV	Digital	1 (4.8)	1 (4.8)	0 (0.0)	3 (14.3)	1 (4.8)	14 (66.7)	1 (4.8)	2.63	0.85
	Ink	2 (9.5)	1 (4.8)	1 (4.8)	4 (19.0)	0 (0.0)	12 (57.1)	1 (4.8)		
LV	Digital	-	-	-	1 (5.0)	-	19 (95.0)	-	0.00	1.00
	Ink	-	-	-	1 (4.8)	-	20 (95.2)	-		
Digital vs Lipstick										
LI	Digital	1 (4.8)	1 (4.8)	6 (28.6)	4 (19.0)	4 (19.0)	5 (23.8)	-	0.23	1.00
	Lipstick	1 (4.8)	1 (4.8)	6 (28.6)	3 (14.3)	4 (19.0)	6 (28.6)	-		
LII	Digital	3 (14.3)	1 (4.8)	2 (9.5)	2 (9.5)	0 (0.0)	10 (47.6)	3 (14.3)	2.87	0.83
	Lipstick	2 (9.5)	1 (4.8)	4 (19.0)	2 (9.5)	1 (4.8)	10 (47.6)	1 (4.8)		
LIII	Digital	4 (19.0)	1 (4.8)	1 (4.8)	-	1 (4.8)	13 (61.9)	1 (4.8)	1.33	0.93
	Lipstick	4 (19.0)	1 (4.8)	2 (9.5)	-	1 (4.8)	13 (61.9)	0 (0.0)		
LIV	Digital	1 (4.8)	1 (4.8)	0 (0.0)	3 (14.3)	1 (4.8)	14 (66.7)	1 (4.8)	2.37	0.88
	Lipstick	2 (9.5)	1 (4.8)	1 (4.8)	3 (14.3)	0 (0.0)	13 (61.9)	1 (4.8)		
LV	Digital	-	-	-	1 (5.0)	-	19 (95.0)	-	0.00	1.00
	Lipstick	-	-	-	1 (4.8)	-	20 (95.2)	-		

plain arch (PA), tented arch (TA), ulnar loop (UL), spiral whorl (SW), plain whorl (PW), double whorl (DW) and central pocket whorl (CPW), X² = Chi-square value

Table 2. Percentage Frequencies of digit patterns and Chi-square test to determine if differences exist between digital and other methods (male subjects)

Finger	Method	CPW	DL	PA	PW	SW	UL	TA	Chi-square analysis	
									X ²	P-value
Digital and Ink										
LI	Digital	-	1 (9.1)	3 (27.3)	2 (18.2)	-	5 (45.5)	-	0.48	0.92
	Ink	-	1 (9.1)	4 (36.4)	1 (9.1)	-	5 (45.5)	-		
LII	Digital	2 (18.2)	1 (9.1)	2 (18.2)	1 (9.1)	-	4 (36.4)	1 (9.1)	1.11	0.95
	Ink	1 (9.1)	1 (9.1)	1 (9.1)	1 (9.1)	-	5 (45.5)	2 (18.2)		
LIII	Digital	3 (27.3)	-	1 (9.1)	-	-	6 (54.5)	1 (9.1)	1.61	0.66
	Ink	2 (18.2)	-	2 (18.2)	-	-	7 (63.6)	0 (0.0)		
LIV	Digital	1 (9.1)	1 (9.1)	0 (0.0)	1 (9.1)	1 (9.1)	6 (54.5)	1 (9.1)	2.42	0.88
	Ink	1 (9.1)	1 (9.1)	1 (9.1)	2 (18.2)	0 (0.0)	5 (45.5)	1 (9.1)		
LV	Digital	-	-	-	1 (9.1)	-	10 (90.9)	-	0.00	1.00
	Ink	-	-	-	1 (9.1)	-	10 (90.9)	-		
Digital and Lipstick										
LI	Digital	-	1 (9.1)	3 (27.3)	2 (18.2)	0 (0.0)	5 (45.5)	-	2.53	0.64
	Lipstick	-	1 (9.1)	2 (18.2)	1 (9.1)	2 (18.2)	5 (45.5)	-		
LII	Digital	2 (18.2)	1 (9.1)	2 (18.2)	1 (9.1)	-	4 (36.4)	1 (9.1)	0.44	0.99
	Lipstick	1 (9.1)	1 (9.1)	2 (18.2)	1 (9.1)	-	5 (45.5)	1 (9.1)		
LIII	Digital	3 (27.3)	-	1 (9.1)	-	-	6 (54.5)	1 (9.1)	1.61	0.66
	Lipstick	2 (18.2)	-	2 (18.2)	-	-	7 (63.6)	0 (0.0)		
LIV	Digital	1 (9.1)	1 (9.1)	0 (0.0)	1 (9.1)	1 (9.1)	6 (54.5)	1 (9.1)	2.00	0.92
	Lipstick	1 (9.1)	1 (9.1)	1 (9.1)	1 (9.1)	0 (0.0)	6 (54.5)	1 (9.1)		
LV	Digital	-	-	-	1 (9.1)	-	10 (90.9)	-	0.00	1.00
	Lipstick	-	-	-	1 (9.1)	-	10 (90.9)	-		

plain arch (PA), tented arch (TA), ulnar loop (UL), spiral whorl (SW), plain whorl (PW), double whorl (DW) and central pocket whorl (CPW), X² = Chi-square value

Table 3. Percentage Frequencies of digit patterns and Chi-square test to determine if differences exist between digital and other methods (female subjects)

Finger	Method	CPW	DL	PA	PW	SW	UL	TA	Chi-square analysis	
									X ²	P-value
Digital and ink										
LI	Digital	1 (10.0)	-	3 (30.0)	2 (20.0)	4 (40.0)	0 (0.0)	-	1.33	0.86
	Ink	1 (10.0)	-	3 (30.0)	1 (10.0)	4 (40.0)	1 (10.0)	-		
LII	Digital	1 (10.0)	-	0 (0.0)	1 (10.0)	0 (0.0)	6 (60.0)	2 (20.0)	2.42	0.79
	Ink	1 (10.0)	-	1 (10.0)	1 (10.0)	1 (10.0)	5 (50.0)	1 (10.0)		
LIII	Digital	1 (10.0)	1 (10.0)	-	-	1 (10.0)	7 (70.0)	-	2.08	0.56
	Ink	3 (30.0)	1 (10.0)	-	-	0 (0.0)	6 (60.0)	-		
LIV	Digital	0 (0.0)	-	-	2 (20.0)	-	8 (80.0)	-	1.07	0.59
	Ink	1 (10.0)	-	-	2 (20.0)	-	7 (70.0)	-		
LV	Digital	-	-	-	-	-	10 (100.0)	-	-	-
	Ink	-	-	-	-	-	10 (100.0)	-	-	-
Digital and Lipstick										
LI	Digital	1 (10.0)	-	3 (30.0)	2 (20.0)	4 (40.0)	0 (0.0)	-	1.81	0.77
	Lipstick	1 (10.0)	-	4 (40.0)	2 (20.0)	2 (20.0)	1 (10.0)	-		
LII	Digital	1 (10.0)	-	0 (0.0)	1 (10.0)	0 (0.0)	6 (60.0)	2 (20.0)	5.09	0.40
	Lipstick	1 (10.0)	-	2 (20.0)	1 (10.0)	1 (10.0)	5 (50.0)	0 (0.0)		
LIII	Digital	1 (10.0)	1 (10.0)	-	-	1 (10.0)	7 (70.0)	-	0.41	0.94
	Lipstick	2 (20.0)	1 (10.0)	-	-	1 (10.0)	6 (60.0)	-		
LIV	Digital	0 (0.0)	-	-	2 (20.0)	-	8 (80.0)	-	1.07	0.59
	Lipstick	1 (10.0)	-	-	2 (20.0)	-	7 (70.0)	-		
LV	Digital	-	-	-	-	-	9 (100.0)	-	-	-
	Lipstick	-	-	-	-	-	10 (100.0)	-	-	-

plain arch (PA), tented arch (TA), ulnar loop (UL), spiral whorl (SW), plain whorl (PW), double whorl (DW) and central pocket whorl (CPW), X² = Chi-square value

Table 4. Descriptive statistics and Test for differences in ATD angles and TRFC between Improvise digital and other methods in all participants

Finger	Method	N	Mean	SD	SE	T-test	
						t-value	P-value
Digital and Ink							
ATD ANGLE	Digital	21	39.30	3.19	0.70	-6.26	0.00*
	Ink	21	70.90	22.91	5.00		
TFRC	Digital	19	72.47	22.59	5.18	6.30	0.00*
	Ink	21	39.55	3.12	0.68		
Digital and Lipstick							
ATD ANGLE	Digital	21	39.30	3.19	0.70	-8.82	0.00*
	Lipstick	20	80.10	20.45	4.57		
TFRC	Digital	19	72.47	22.59	5.18	6.32	0.00*
	Lipstick	21	39.37	3.35	0.73		

N = sample size; SD = standard deviation; SE = standard error of mean

Table 5. descriptive statistics and Test for differences in ATD angles and TRFC between Improvise digital and other methods in male participants

Finger	Method	N	Mean	SD	SE	T-test	
						t-value	P-value
Digital and ink							
ATD ANGLE	Digital	11	38.70	3.13	0.94	-3.39	0.01*
	Ink	11	67.27	27.81	8.39		
TFRC	Digital	10	71.10	28.16	8.90	3.53	0.01*
	Ink	11	39.50	2.65	0.80		
Digital and Lipstick							
ATD ANGLE	Digital	11	38.70	3.13	0.94	-5.26	0.00*
	Lipstick	10	77.40	23.09	7.30		
TFRC	Digital	10	71.10	28.16	8.90	3.58	0.01*
	Lipstick	11	39.00	3.34	1.01		

N = sample size; SD = standard deviation; SE = standard error of mean

Table 6. Descriptive statistics and Test for differences in ATD angles and TRFC between Improvise digital and other methods in female participants

Finger	Method	N	Mean	SD	SE	T-test	
						t-value	P-value
Digital and Ink							
ATD ANGLE	Digital	10	39.95	3.29	1.04	-6.56	0.00*
	Ink	10	74.90	16.52	5.22		
TFRC	Digital	9	74.00	15.86	5.29	6.35	0.00*
	Ink	10	39.60	3.72	1.18		
Digital and Lipstick							
ATD ANGLE	Digital	10	39.95	3.29	1.04	-4.47	0.00*
	Lipstick	9	76.33	24.23	8.08		
TFRC	Digital	9	74.00	15.86	5.29	6.58	0.00*
	Lipstick	10	38.60	3.23	1.02		

N = sample size; SD = standard deviation; SE = standard error of mean

could result in blurred print. Gupta and Gupta [33] described the lipstick and they mention it easy and more user friendly than the ink method. The results of this study showed that digit patterns were identifiable when analyzed qualitatively using ink, lipstick and Improvise

digital methods. This is an indication that a carefully taken finger print using of any the method gives comparatively reliable result of the type of dermal ridge. But most participants preferred the Improvise digital method because of the common problem of over inking,

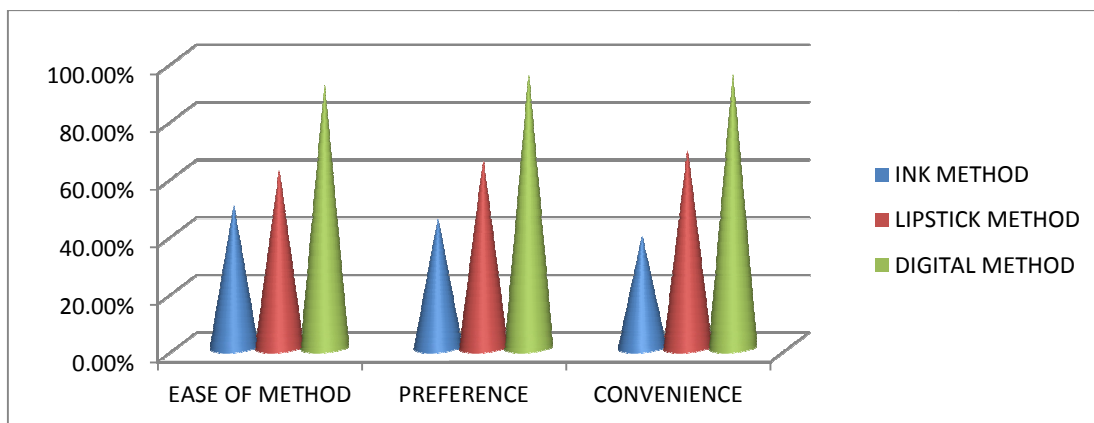


Fig. 4. Graphical representation of participants' responsiveness

under inking, smudging, cleaning the stains from the hands and the possibility of an allergic reaction to the chemicals found in the ink method. One major problem observed with the lipstick is the tendency for the paper to adhere to the hand but this depends on the type of lipstick. Sticking occurs mostly with “oil” and “wet” lipsticks, it result in blurring of the patterns due to spreading of the ridge lines. With the dry lipstick, this problem is greatly reduced. There is the need to be mindful of the quality of the lipstick, as blurred prints whether from ink or lipstick methods could lead to wrong identification, wrong data, wrong analysis, errors and wrong inferences.

The quantitative analysis of TFRC and ATD angles differ significantly between the Improvise method and the others. This could be as a result of the clarity of the print and the ability to magnify them is such a way that they could be legible to analyze. Taking a point between the core and triradi to count the ridge was more difficult in the lipstick print compare to other methods. It was easier in the improved digital method as the well delineated lines are clear enough to count especially when the scan is magnified. In same vein, measurement of the ATD angle also depends on clarity of triradii t, a and d. In addition proper placement of the protractor along lines TA, TD and AD.

The participants preferred the Improvise digital method due to ease of taking palm print, convenience of not being stain with a dye either from the ink or lipstick. Application of readily available technologies will greatly enhance scientific research. Unlike in more advanced economies, researchers in Third World countries

like Nigeria are faced with infrastructural inadequacies and the technical manpower available in advanced countries. The constant review of dermaloglyphics methods as have been done in this study will help to resolve the challenges of infrastructure and techniques and make the results from researches more reliable, and even cheaper in the long run. Using the AutoCAD software, gave a better precision of measurement and a competency in one digital technology can boost researchers' confidence in upcoming research technologies and innovations.

4. CONCLUSION

The ink, lipstick and Improvise digital methods have their comparable advantages. Qualitative digit patterns could be identified and analyzed easily with all three methods. However, quantitative analyses were better analyzed with the Improvise digital method. The Improvise digital method is easy, user friendly, most preferred by participants. In addition, the equipment needed is common and easily accessible even in research facilities in developing countries

CONSENT

Participants' gave written informed consents to have their finger and palmar prints taken

ETHICAL APPROVAL

This research received ethical approval from the Ethics' Committee, Biomedical Technology University of Port Harcourt, Rivers State, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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