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Original Article

Investigation of inheritance pattern of palmar creases among the Urhobo and Ogoni Ethnic Groups in South-South Nigeria

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ABSTRACT

Background and aim: Qualitative and quantitative analysis of palmar creases have been implicated for diagnoses of congenital abnormalities as well as prediction of identity, ancestry, and ethnicity. Thus, suggesting the genetic basis of palmar creases. This study investigated the inheritance pattern of palmar creases among the Urhobo and Ogoni ethnic groups in South-South Nigeria.
Methodology: In this family-based study 95 families- 60 Urhobo and 35 Ogoni families were recruited. Using dermatoglyphic capture technique, palm prints of the subjects were obtained. Proportion of Concordance was used to determine inheritability. Mendelian Chi-square analysis of trait dominance was used to establish dominant patterns.
Results: Inheritance likelihood of pattern of origin of major palmar creases among the Urhobos was 78.3% and 83.3% on the right and left palms respectively while that of Ogoni showed 85.7% on the right palm and 77.1% on the left palm; shape of palmar creases of the Urhobos was 90.0% on the right palm and 93.3% on the left palm while that of the Ogoni was 88.6% and 88.6% on the right and left palms respectively; Middle/Mid longitudinal crease for Urhobo was 88.3% and 93.3% on the right and left palms respectively while that of the Ogoni was 85.7% on the right and left palms respectively.
Conclusion: The inheritance of origin/meeting pattern of the major creases is purely under the influence of more than two alleles while that of shape and Middle longitudinal crease tend to suggest a di-allelic influenced expression. Middle longitudinal crease showed purely a dominant-recessive expression.

Keywords:
Palmar creases; Polygenic Inheritance; Major palmar creases; Minor palmar creases

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INTRODUCTION

Line of formations of the palm readily evident at birth is called palmar crease. Qualitative and quantitative analysis of palmar crease has been implicated for diagnoses of chromosomal aberrations and congenital abnormalities, as well as being insightful in revealing the identity, ancestry, ethnicity and some anthropologic characteristics of individuals. These underpin the genetic basis of palmar crease trait (Bharadwaja *et al.,* 2004; Sharma *et al.,* 2007; Oyinbo and Fawehinmi, 2008; Park *et al., 2*010; Adetona *et al.*, 2012; Koneru *et al.*, 2013; Fourner and Ross, 2015; Igbigbi *et al*., 2018; Haroun, 2019; Omuruka *et al.,* 2022a).

Several literatures have identified three Major (Primary) palmar creases and some Minor creases. The three Major creases are Proximal transverse crease, Distal transverse crease, and Radial longitudinal crease. The Minor Palmar creases are narrower than the major creases and they either cross the major creases, palm creases or are far apart from major creases. They include amongst others Middle (Mid) longitudinal crease, Ring finger crease, Little finger crease, Ulnar longitudinal crease etc (Park *et al*., 2010; Okoro, 2015; Mekbeb, 2019).

Omuruka *et al.* (2022b), further proposed a "one system" and a "three system" classification models of palmar creases in bit to provide a more detail and holistic grouping of palmar crease variants. In the "one system" classification model the types/variants identified are Type 1, Type 2 and Type 3 - based on pattern of origin/meeting pattern of major palmar creases; Type M and Type V - based on pattern of shape/appearance of palmar creases; Type Y and Type X - based on presence/absence of middle longitudinal crease. These types/patters are described below;

Type 1: A single (one) head/point of origin for all the major creases (or fusion of Radial longitudinal, Proximal transverse and Distal transverse creases

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creases at their point of origin or at any point).

Type 2: A single (one) head/point of origin of Radial longitudinal and Proximal transverse creases (or fusion of Radial longitudinal and Proximal transverse creases at their point of origin or at any point) and a separate origin of Distal transverse Crease.

Type 3: Separate heads of origin (or non-fusion) of Radial longitudinal, Proximal transverse and Distal transverse creases.

Type Y: Middle longitudinal crease is present.

Type X: Middle longitudinal crease is absent.

Type M: shape resembling letter "M".

Type V: any other appearance/shape other than letter "M".

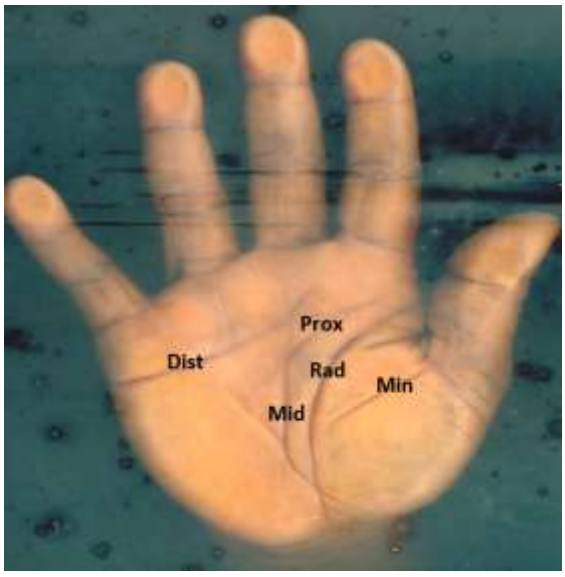


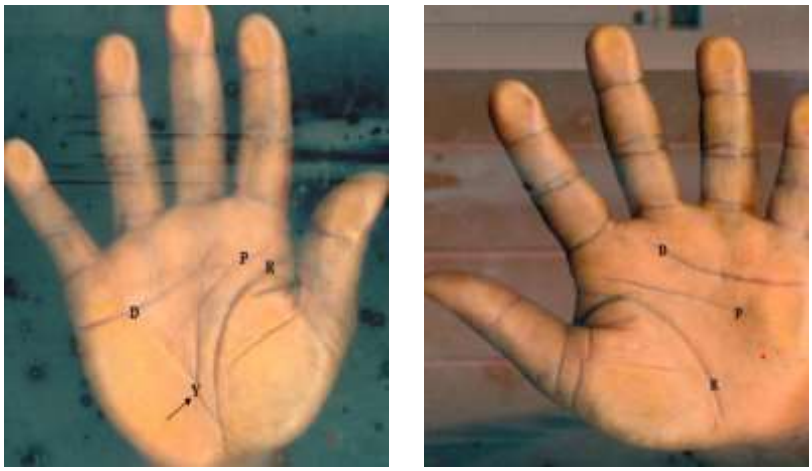
Figure 1: Major and Minor Creases. Radial longitudinal Crease (Rad), Proximal transverse Crease (Prox), Distal transverse Crease (Dist), Mid Longitudinal Crease, other Minor creases (Min) (Adapted from Omuruka *et al.*, 2022b).

Type 1 Type 2 Type 3

Figure 2: Variants based on pattern of origin/meeting pattern of major palmar creases. (Adapted from Omuruka *et al.*, 2022b). Arrow heads show point of origin

Type M Type V

Figure 3: Variants based on shape/appearance of palmar crease. (Adapted from Omuruka *et al.*, 2022b).



Type Y Type X

Figure 4: Variants based on presence/absence of middle longitudinal crease. (Adapted from Omuruka *et al.*, 2022b). Arrow shows middle longitudinal crease

Aim: This research was aimed at investigating the inheritability, inheritance pattern, and dominant pattern type of palmar crease variants among the Urhobo and Ogoni ethnic groups.

MATERIALS AND METHODS

Study Area and the People

The Urhobo people are the major ethnic group in Delta State and include the people of Okpe, Uvwie, Agbon, Abraka, Ughelli, Agbassa, and Oghara, which are found in the following Local Government Areas; Ethiope East, Ethiope West, Ughelli North, Ughelli South, Okpe, Sapele, Udu, Uvwie, and Warri. With the exception of Warri South (which is part of Delta South Senatorial District), they constitute Delta Central Senatorial District. From the 2006 census, the population of Urhobo is put at 1, 882, 828 (Ekeh, 2007; Orhero, 2015; NPC, 2006; NBS, 2010).

The area called Ogoni land makes up the majority of Rivers-East Senatorial District comprising of six kingdoms (Babbe, Eleme, Gokhana, Ken-Khana, Nyo-Khana, and Tai) which constitute Eleme, Khana, Gokana, and Tai local government area. As at 2006 the Ogoni population is 837, 239 (Vobnu, 2001; Chereji and King, 2015; NPC, 2006; NBS, 2010).

Study Sample and Sample Size Determination

In this family-based study 95 families- 60 Urhobo and 35 Ogoni families (comprising of father, mother and at least a child) were recruited by multi-stage sampling technique. Using 2006 Nigerian census figure the population of the study was projected to 2024 using the formulae;

Population Projection formulae = $P_o \times [1+ (r / 100)]^t$ ..... *equation I*

Where; P_o = current population (from 2006 census), r = growth rate = 2.9, t = projection time difference (from 2006 to 2024) = 18 years

From the projected figure, minimum sample size (family size/number of families) was determined using Cochran, (1963) sample size (SS) determination formulae:

$SS = \frac{z^2 x\ p\ x\ q}{d^2}$ ..... *equation II*

Where; SS = Sample Size, p = Proportion of population (Proportion of family size), z = Z value = 1.96 (for 95% confidence level), q = 1-p, d = Confidence interval = 3% (tolerance level of confidence of 0.03).

Thus, minimum sample size (family size) of 56 families and 25 families of Urhobo and Ogoni ethnic groups respectively were determined.

Criteria for Subject Selection

A family was considered to participate in the study if the parents, grandparents and great grandparents of the man (father) and the woman (mother) are from the same ethnic group, and every recruited family had at least an offspring (not adopted). Subjects selected were from the ages of five (5) and above, and had no form of anatomical abnormality of any of the palms and creases.

Ethical Consideration

Informed consent letter was issued to the participants and procedure and purpose of the study explained to them before being recruited for the study.

Methods of Data Collection

Oghenemavwe and Osaat (2015) dermatoglyphic capture technique was used to obtain palm print. In this method Hp G3110 Photo (print) scanner connected to a laptop via a USB cord and powered with 100watt solar power inverter connected to 12volts rechargeable battery was used to capture the palm. The palm image was then magnified and the variant pattern types of the "one system classification model" of palmar creases as proposed by Omuruka *et al.* (2022b) was adopted, observed, identified and recorded.

Data Analysis

Statistical analysis was performed using Statistical Package for the Social (SPSS IBM version 23.0). Parental combinations and offspring outcome for each pattern type of palmar creases were observed and tabulated, and Proportion of Concordance was used to determine inheritability (inheritance likelihood) of palmar crease. Mendelian Chi-square analysis of trait dominance was also used to establish dominant pattern of palmar crease. All analyses were carried out at 95% confidence level and significance was taken at $P<0.05$.

RESULTS

Table 1 showed that 60 Urhobo families (comprising of father, mother and at least a child) of 180 subjects and 35 Ogoni families (comprising of father, mother and at least a child) of 105 subjects were respectively sampled.

The distribution of palmar crease variants based on head/point of origin or pattern of meeting of the major creases of Urhobo and Ogoni were presented in Tables 2a and 2b respectively. For the Urhobo, the parents had 55.0% of Type 2 and 45.0% of Type 3 on the right hand/palm while on the left palm Type 2 and Type 3 were 61.7% and 38.3% respectively whereas the offspring had 61.7% of Type 2 and 38.3% of Type 3 on the right palm and 56.7% of Type 2 and 43.3% of Type 3 on the left palm. There were more of Type 2 (58.6%) than Type 3 (41.4%) in all the subjects (parents and offspring) while no Type 1 was observed. For the Ogoni, the parents had 1.4% of Type 1, 50.0% of Type 2 and 48.6% of Type 3 on the right hand/palm while on the left palm Type 2 and Type 3 were 45.7% and 54.3% respectively whereas the offspring had 51.4% of Type 2 and 48.6% of Type 3 on the right palm and 45.7% of Type 2 and 54.3% of Type 3 on the left palm. There were more of Type 2 (50.9%) than Type 3 (48.6%) and Type 1 (0.5%) in all the studied population (parents and offspring).

The percentage distribution of types/patterns of palmar crease shape of were presented in Tables 3a and 3b respectively. Among the Urhobo (Table 3a), parents had 77.5% of Type M and 22.5% of Type V on the right hand/palm while on the left palm Type M was 72.5% and Type V was 27.5% whereas the offspring had 81.7% of Type M and 18.3% of Type V on the right palm and 80.0% of Type M and 20.0% of Type V on the left palm. There were more of Type M (76.9%) than Type V (23.1%) in all the subjects (parents and offspring). Among the Ogoni (Table 3b), parents had 31.4% of Type M and 68.6% of Type V on the right hand/palm while on the left palm Type M was 38.6% and Type V was 61.4% whereas the offspring had 22.9% of Type M and 77.1% of Type V on the right palm and 22.9% of Type M and 77.1% of Type V on the left palm. There were more of Type V (69.0%) than Type M (31.0%) in all the subjects (parents and offspring) sampled.

Tables 4a and 4b showed the percentage distribution of presence of Middle Longitudinal Crease respectively. Among the Urhobo (Table 4a), parents had 84.2% of Type Y and 15.8% of Type X on the right palm while on the left palm Type Y was 89.2% and Type X was 10.8% whereas the offspring had 75.0% of Type Y and 25.0% of Type X on the right palm and 86.7% of Type Y and 13.3% of Type X on the left palm. There were more of Type Y (84.7%) than Type X (15.3%) in all the subjects (parents and offspring). Among the Ogoni (Table 4b), parents had 61.4% of Type Y and 38.6% of Type X on the right hand while on the left palm Type Y was 65.7% and Type X was 34.3% whereas the offspring had 48.6% of Type Y and 51.4% of Type X on the right palm and 51.4% of Type Y and 48.6% of Type X on the left palm. There were more of Type Y (59.0%) than Type X (41.0%) in all the subjects (parents and offspring) sampled.

Tables 5a and 5b showed parental combinations and offspring outcome and inheritance likelihood (inheritability) of major palmar crease variants based on pattern of heads of origin/meeting pattern among the study population. Among the Urhobo (Table 5a), the inheritance likelihood was 47/60 (78.3%) and 50/60 (83.3%) on the right and left palms respectively. On the right palm; Type 2 was 17 in offspring while Type 3 showed discordance of 4 in offspring when both parents were Type 2, and when both parents were Type 3 offspring had 6 Type 3 and showed 9 discordance of Type 2. But when either of the parents were Type 2/Type 3 or Type 3/Type 2 the offspring had 11 Type 2 and 13 Type 3. On the left palm; when both parents were Type 2 offspring had 17 Type 2 and 6 discordance of Type 3, and when both parents were Type 3 offspring had 5 Type 3 and 4 discordance of Type 2. When either of the parents were Type 2/Type 3 or Type 3/Type 2 the offspring had 13 Type 2 and 15 Type 3. There were no parental combinations of Type 1, Type 1/Type 2 or Type 2/Type 1, and Type 1/Type 3 or Type 3/Type 1 observed in both hands. Similarly, among the Ogoni the inheritance likelihood was 30/35 (85.7%) on the right palm and 27/35 (77.1%) on the left palm. When both parents were Type 2 offspring had 3 and 5 Type 2 on the right and left hands respectively, and 4 and 5 discordances of Type 3 on the right and left palm respectively. When both parents were Type 3 offspring had 7 and 4 Type 3 on the right and left hands respectively, 2 and 3 discordances of Type 2 on the right and left palm respectively. On the right; when either of the parents were Type 1/Type 2 or Type 2/Type 1 offspring had 1 Type 2, when either of the parents were Type 2/Type 3 or Type 3/Type 2 the offspring had 13 Type 2 and 6 Type 3. On the left; when either of the parents were Type 2/Type 3 or Type 3/Type 2 offspring had 8 Type 2 and 10 Type 3. There were no parental combination of Type 1/Type 2 or Type 2/Type 1on the left palm. Also, no parental combinations of Type 1, and Type 1/Type 3 or Type 3/Type 1 were observed in both hands.

In Table 6a the inheritance likelihood of shape of palmar creases among the Urhobo was presented to be 54/60 (90.0%) on the right palm and 56/60 (93.3%) on the left palm. On the right; when either of the parents were Type M/Type V or Type V/Type M offspring had 13 Type M and 8 Type V, when both parents were Type M offspring had 33 Type M and a discordance of 3 of Type V, when both parents were Type V offspring had 3 discordance of Type M and no Type V. On the left palm; when either of the parents were Type M/Type V or Type V/Type M offspring had 14 Type M and 9 Type V, when both parents were Type M offspring

had 31 Type M and a discordance of 1 of Type V, when both parents were Type V offspring had 2 Type V and a discordance of 3 of Type M. In Table 6b the inheritance likelihood of shape of crease among the Ogoni was 31/35 (88.6%) and 31/35 (88.6%) on the right and left palms respectively. On the right; when both parents were Type M offspring had 1 Type M and a discordance of 3 of Type V, when both parents were Type V offspring had 17 of Type V and 1 discordance of Type M, and when either of the parents were Type M/Type V or Type V/Type M offspring had 6 Type M and 7 Type V. On the left; when both parents were Type M offspring had 2 Type M and a discordance of 3 of Type V, when both parents were Type V offspring had 12 of Type V and a 1 discordance of Type M, and when either of the parents were Type M/Type V or Type V/Type M offspring had 5 Type M and 12 Type V.

In Table 7a the Urhobo population had an inheritance likelihood (inheritability factor) of 53/60 (88.3%) on the right and 56/60 (93.3%) on the left for palmar crease variants based on Middle longitudinal. On the right; when both parents were Type Y offspring had 36 Type Y and a discordance of 6 of Type X, when both parents were Type X offspring had 3 of Type X and 1 discordance of Type Y, and when either of the parents were Type X/Type Y or Type Y/Type X offspring had 8 Type Y and 3 Type X. On the left palm; when both parents were Type Y offspring had 43 Type Y and a discordance of 4 of Type X, and when either of the parents were Type X/Type Y or Type Y/Type X offspring had 9 Type Y and 4 Type X. There was no Type X combination in offspring. Similarly, among the Ogoni (Table 7b) the inheritance likelihood of Middle longitudinal crease was 30/35 (85.7%) on the right and 32/35 (91.4%) on the left. On the right; when both parents were Type Y offspring had 12 Type Y and a discordance of 5 of Type X, when both parents were Type X offspring had 5 of Type X and no discordance, and when either of the parents were Type X/Type Y or Type Y/Type X offspring had 5 Type Y and 8 Type X. On the left palm; when both parents were Type Y offspring had 13 Type Y and a 3 discordance of Type X, when both parents were Type X offspring had 5 of Type X with no discordance, and when either of the parents were Type X/Type Y or Type Y/Type X offspring had 5 Type Y and 9 Type X.

Mendelian Chi-square test of dominance for palmar crease variants based on shape among the Urhobo and Ogoni groups were presented in Tables 8a, 8b, and 9a, 9b respectively. Similarly, that of Middle longitudinal crease among the groups were as shown in Tables 10a, 10b, 11a, 11b. Mendelian Chi-square analysis posit that if a trait is dominant over the other it will have a distribution result that is less than the critical Chi-square value of 3.841 which indicates insignificance. On the right palm among the Urhobo group (Table 8a): when Type M was assumed to be dominant, insignificance was observed for all parental combinations. [That is, when both parents were Type M Mendelian chi-square (X^2cal) = 0.250, when both parents were Type V X^2cal = 3.048, when parents' combination were heterozygous (Type M/V) X^2cal = 1.000]; when Type V was assumed to be dominant, significance was observed for all parental combinations (that is homozygous and heterozygous combination). On the left palm among the Urhobo group (Table 8b): when Type M was assumed to be dominant all parental combination showed to be insignificance- X^2cal = 0.031 for both parents having Type M, X^2cal = 3.522 for both parents having Type V and X^2cal = 0.600 for both parents having Type M/V; when Type V was assumed dominant all combination were significantly different from the Mendelian distribution except when parental combination was heterozygous (Type M/V) which had X^2cal = 3.267. Among Ogoni population (Tables 9a and 9b), all Types M and V combination followed Mendelian distribution (were insignificant) when Type V was assumed to be dominant in both right palm (X^2cal = 0.250 for both parents having Type M; X^2cal = 3.630 for both parents having Type M/V; X^2cal = 2.769 for both parents having Type V) and left palm (X^2cal = 0.800 for both parents Type M; X^2cal = 2.077 for both parents Type M/V; X^2cal = 1.471 for both parents Type V). But there where variation/inconsistency in the Mendelian Chi-square distribution in both hands/palms when Type M was assumed to be dominant. Type M parental combination (when both parents were Type M) and Type V parental combination (when both parents were Type V) were respectively insignificant (X^2cal = 2.250 and X^2cal = 3.769) on the right, and on the left Type M parental combination (when both parents were Type M) was insignificant (X^2cal = 1.800). Similarly, Mendelian Chi-square distribution for Types X/Y among the Urhobo population were insignificant-X^2cal = 2.250 for both parents having Type X; X^2cal = 3.267 for combination of Type Y/X in parents; X^2cal = 0.818 for both parents having Type Y in all parental combination on the right palm (Table 10a) and when both parents were Type Y on the left palm (Table 10b) having X^2cal = 1.231 on assumption that Type Y was dominant. On assumption that Type X was dominant in both palms, Mendelian distribution (X^2cal = 0.250) was only observed when both parents were Type X on the right palm. Also, in Tables 11a and 11b the Mendelian Chi-square analysis of dominance for Types X/Y palmar crease pattern among the Ogoni population showed that when Type X was assumed to be dominant on the right and left palms, Type X combination in both parents was insignificance (X^2cal = 0.000 for each palm) as well as Type Y combination in both parents (X^2cal = 1.923 for right palm and X^2cal = 1.786 for left palm); when Type Y was assumed to be dominant on the right and left palms Type X/Y combination in parents was insignificance (X^2cal = 0.176 for right palm and X^2cal = 0.333 for left palm) and only Type X combination in both parents was insignificance (X^2cal = 0.000) for left palm.

Table 1: Distribution of sample population size

Ethnic group	No. of Family	No. of subject
Urhobo	60	180
Ogoni	35	105

Table 2a: Percentage Distribution of Types/Pattern of head/point of origin of major creases for Urhobo ethnic group

Types based on head of origin	Right Hand			Left Hand			
	No in Parents	No in Offspring	Total no	No in Parents	No in Offspring	Total no	Grand total
Type 1	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Type 2	66 (55.0%)	37 (61.7%)	103 (57.2%)	74 (61.7%)	34 (56.7%)	108 (60.0%)	211 (58.6%)
Type 3	54 (45.0%)	23 (38.3%)	77 (42.8%)	46 (38.3%)	26 (43.3%)	72 (40.0%)	149 (41.4%)

Type 2 > Type 3 > Type 1 in each palm and in both palms

Table 2b: Percentage Distribution of Types/Pattern of head/point of origin of major creases for Ogoni ethnic group

Types based on head of origin	Right Hand			Left Hand			
	No in Parents	No in Offspring	Total no	No in Parents	No in Offspring	Total no	Grand total
Type 1	1 (1.4%)	0 (0.0%)	1 (1.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%	1 (0.5%)
Type 2	35 (50.0%)	18 (51.4%)	53 (50.4%)	38 (54.3%)	16 (45.7%)	54 (51.4%)	107 (50.9%)
Type 3	34 (48.6%)	17 (48.6%)	51 (48.6%)	32 (45.7%)	19 (54.3%)	51 (48.6%)	102 (48.6%)

Type 2 > Type 3 > Type 1 in each palm and in both palms

Table 3a: Percentage distribution of Types/patterns of shape of creases for Urhobo ethnic group

Types based on head of origin	Right Hand			Left Hand			
	No in Parents	No in Offspring	Total no	No in Parents	No in Offspring	Total no	Grand total
Type M	93 (77.5%)	49 (81.7%)	142 (78.9%)	87 (72.5%)	48 (80.0%)	135 (75.0%)	277 (76.9%)
Type V	27 (22.5%)	11 (18.3%)	38 (21.1%)	33 (27.5%)	12 (20.0%)	45 (25.0%)	83 (23.1%)

Type M > Type V in each palm and in both palms

Table 3b: Percentage distribution of Types of shape/patterns of creases for Ogoni ethnic group

Types based on head of origin	Right Hand			Left Hand			
	No in Parents	No in Offspring	Total no	No in Parents	No in Offspring	Total no	Grand total
Type M	22 (31.4%)	8 (22.9%)	30 (28.6%)	27 (38.6%)	8 (22.9%)	35 (33.3%)	65 (31.0%)
Type V	48 (68.6%)	27 (77.1%)	75 (71.4%)	43 (61.4%)	27 (77.1%)	70 (66.7%)	145 (69.0%)

Type V > Type M in each palm and in both palms

Table 4a: Percentage distribution of presence of Middle Longitudinal Crease (MLC) for Urhobo ethnic group

Types based on head of origin	Right Hand			Left Hand			
	No in Parents	No in Offspring	Total no	No in Parents	No in Offspring	Total no	Grand total
Type Y	101 (84.2%)	45 (75.0%)	146 (81.1%)	107 (89.2%)	52 (86.7%)	159 (88.3%)	305 (84.7%)
Type X	19 (15.8%)	15 (25.0%)	34 (18.9%)	13 (10.8%)	8 (13.3%)	21 (11.7%)	55 (15.3%)

Type Y > Type X in each palm and in both palms

Table 4b: Percentage distribution of presence of Middle Longitudinal Crease (MLC) for Ogoni ethnic group

Types based on head of origin	Right Hand			Left Hand			
	No in Parent	No in Offspring	Total no	No in Parent	No in Offspring	Total no	Grand total
Type Y	43 (61.4%)	17 (48.6%)	60 (57.1%)	46 (65.7%)	18 (51.4%)	64 (61.0%)	124 (59.0%)
Type X	27 (38.6%)	18 (51.4%)	45 (42.9%)	24 (34.3%)	17 (48.6%)	41 (39.0%)	86 (41.0%)

Type Y > Type X in each palm and in both palms

Table 5a: Parental combinations and offspring outcome and Calculation of inheritance likelihood using Proportion of concordance- based on heads of origin for Urhobo ethnic group

Pattern Combinations in parents	Offspring (Right Hand)				Offspring (Left Hand)			
	T1	T2	T3	Likelihood	T1	T2	T3	Likelihood
Both T1^{++}	-	-	-		-	-	-	
Both T2	0	17	4*		0	17	6*	
Both T3	0	9*	6	47/60 (78.3%)	0	4*	5	50/60 (83.3%)
T1/T2 or T2/T1^{++}	-	-	-		-	-	-	
T1/T3 or T3/T1^{++}	-	-	-		-	-	-	
T2/T3 or T3/T2	0	11	13		0	13	15	

* = discordance; T1 = Type 1; T2 = Type 2; T3 = Type 3; $^{++}$= such pattern of combination never existed in parents in both palms; - = Not available in offspring since the corresponding pattern of combination never existed in parents

Table 5b: Parental combinations and offspring outcome and Calculation of inheritance likelihood using Proportion of concordance- based on heads of origin for Ogoni ethnic group

Pattern Combinations in parents	Offspring (Right Hand)				Offspring (Left Hand)			
	T1	T2	T3	Likelihood	T1	T2	T3	Likelihood
Both T1^{++}	-	-	-		-	-	-	
Both T2	0	3	4*		0	5	5*	
Both T3	0	2*	7	30/35 (85.7%)	0	3*	4	27/35 (77.1%)
T1/T2 or T2/T1^{+}	0	1	0		-	-	-	
T1/T3 or T3/T1^{++}	-	-	-		-	-	-	
T2/T3 or T3/T2	0	13	6		0	8	10	

* = discordance; T1 = Type 1; T2 = Type 2; T3 = Type 3; $^{++}$= such pattern of combination never existed in parents in both palms; $^{+}$= such pattern of combination never existed in parents in the left palm/hand; - = Not available in offspring since the corresponding pattern of combination never existed in parents

Table 6a: Parental combinations and offspring outcome and Calculation of inheritance likelihood using Proportion of concordance- based on shape of crease for Urhobo ethnic group

Pattern Combinations in parents	Offspring (Right Hand)			Offspring (Left Hand)		
	TM	TV	Likelihood	TM	TV	Likelihood
Both TM	33	3*		31	1*	
Both TV	3*	0	54/60 (90.0%)	3*	2	56/60 (93.3%)
TM/TV or TV/TM	13	8		14	9	

* = discordance TM = Type M TV = Type V

Table 6b: Parental combinations and offspring outcome and Calculation of inheritance likelihood using Proportion of concordance based on shape of crease for Ogoni ethnic group

Pattern Combinations in parents	Offspring (Right Hand)			Offspring (Left Hand)		
	TM	TV	Likelihood	TM	TV	Likelihood
Both TM	1	3*		2	3*	
Both TV	1*	17	31/35 (88.6%)	1*	12	31/35 (88.6%)
TM/TV or TV/TM	6	7		5	12	

* = discordance TM = Type M TV = Type V

Table 7a: Parental combinations and offspring outcome and Calculation of inheritance likelihood using Proportion of concordance- based on presence of middle longitudinal crease for Urhobo ethnic group

Pattern Combinations in parents	Offspring (Right Hand)			Offspring (Left Hand)		
	TX	TY	Likelihood	TX	TY	Likelihood
Both TX^{+}	6	1*		-	-	
Both TY	6*	36	53/60 (88.3%)	4*	43	56/60 (93.3%)
TX/TY or TY/TX	3	8		4	9	

* = discordance, TX = Type X, TY = Type Y, $^{+}$= such pattern of combination never existed in parents in the left palm/hand; - = Not available in offspring since the corresponding pattern of combination never existed in parents

Table 7b: Parental combinations and offspring outcome and Calculation of inheritance likelihood using Proportion of concordance- based on presence of middle longitudinal crease for Ogoni ethnic group

Pattern Combinations in parents	Offspring (Right Hand)			Offspring (Left Hand)		
	TX	TY	Likelihood	TX	TY	Likelihood
Both TX	5	0		5	0	
Both TY	5*	12	30/35 (85.7%)	3*	13	32/35 (91.4%)
TX/TY or TY/TX	8	5		9	5	

* = discordance TX = Type X TY = Type Y

Table 8a: Mendelian Chi-square analysis of trait dominance for Type M/V pattern on assumption that it is a diallelic trait – on the right palm for Urhobo ethnic group

Parental trait combination	If Type M was dominant			If Type V was dominant		
	Calculated	Critical				Inference
Type M in both parents	0.250	3.841	Not significant	30.250	3.841	Significant
Type MV combination in both parents	1.000	3.841	Not significant	9.000	3.841	Significant
Type V in both parents	3.048	3.841	Not significant	8.048	3.841	Significant

Type M appears to be dominant over V

Table 8b: Mendelian Chi-square analysis of trait dominance for Type M/V pattern on assumption that it is a diallelic trait – on the left palm for Urhobo ethnic group

Parental trait combination	If Type M was dominant			If Type V was dominant		
	Calculated	Critical	Inference	Calculated	Critical	Inference
Type M in both parents	0.031	3.841	Not significant	30.031	3.841	Significant
Type MV combination in both parents	0.600	3.841	Not significant	3.267	3.841	Not significant
Type V in both parents	3.522	3.841	Not significant	8.522	3.841	Significant

Type M appears to be dominant over V

Table 9a: Mendelian Chi-square analysis of trait dominance for Type M/V pattern on assumption that it is a diallelic trait – on the right palm for Ogoni ethnic group

Parental trait combination	If Type M was dominant			If Type V was dominant		
	Calculated	Critical	Inference	Calculated	Critical	Inference
Type M in both parents	2.250	3.841	Not significant	0.250	3.841	Not significant
Type MV combination in both parents	46.296	3.841	significant	3.630	3.841	Not significant
Type V in both parents	3.769	3.841	Not significant	2.769	3.841	Not significant

Type V appears to be dominant over M

Table 9b: Mendelian Chi-square analysis of trait dominance for Type M/V pattern on assumption that it is a diallelic trait – on the left palm for Ogoni ethnic group

Parental trait combination	If Type M was dominant			If Type V was dominant		
	Calculated	Critical	Inference	Calculated	Critical	Inference
Type M in both parents	1.800	3.841	Not significant	0.800	3.841	Not significant
Type MV combination in both parents	31.410	3.841	significant	2.077	3.841	Not significant
Type V in both parents	8.471	3.841	significant	1.471	3.841	Not significant

Type V appears to be dominant over M

Table 10a: Mendelian Chi-square analysis of trait dominance for Type X/Y pattern on assumption that it is a diallelic trait – on the right palm for Urhobo ethnic group

Parental trait combination	If Type X was dominant			If Type Y was dominant		
	Calculated	Critical	Inference	Calculated	Critical	Inference
Type X in both parents	0.250	3.841	Not significant	2.250	3.841	Not significant
Type XY combination in both parents	91.267	3.841	Significant	3.267	3.841	Not significant
Type Y in both parents	5.818	3.841	Significant	0.818	3.841	Not significant

Type Y appears to be dominant over X

Table 10b: Mendelian Chi-square analysis of trait dominance for Type X/Y pattern on assumption that it is a diallelic trait– on the left palm for Urhobo ethnic group

Parental trait combination	If Type X was dominant			If Type Y was dominant		
	Calculated	Critical	Inference	Calculated	Critical	Inference
Type X in both parents	N/A	3.841	Inconclusive	N/A	3.841	Inconclusive
Type XY combination in both parents	110.816	3.841	Significant	6.816	3.841	Significant
Type Y in both parents	6.231	3.841	Significant	1.231	3.841	Not significant

Type Y appears to be dominant over X

Table 11a: Mendelian Chi-square analysis of trait dominance for Type X/Y pattern on assumption that it is a diallelic trait – on the right palm for Ogoni ethnic group

Parental trait combination	If Type X was dominant			If Type Y was dominant		
	Calculated	Critical	Inference	Calculated	Critical	Inference
Type X in both parents	0.000	3.841	Not significant	5.000	3.841	Significant
Type XY combination in both parents	18.843	3.841	Significant	0.176	3.841	Not significant
Type Y in both parents	1.923	3.841	Not significant	4.923	3.841	Significant

Type X appears to be dominant over Y

Table 11b: Mendelian Chi-square analysis of trait dominance for Type X/Y pattern on assumption that it is a diallelic trait – on the left palm for Ogoni ethnic group

Parental trait combination	If Type X was dominant			If Type Y was dominant		
	Calculated	Critical	Inference	Calculated	Critical	Inference
Type X in both parents	0.000	3.841	Not significant	0.000	3.841	Not significant
Type XY combination in both parents	27.000	3.841	Significant	0.333	3.841	Not significant
Type Y in both parents	1.786	3.841	Not significant	5.786	3.841	Significant

Type Y appears to exert slight dominance/influence over X

DISCUSSION

Inheritability (inheritance likelihood) and inheritance pattern

According to Daniel and Elizabeth (1998), Joel *et al*. (2002), Miko and LeJeune (2009), and Tobias *et al.* (2011), to use polygenic trait to establish familial or ancestral ties/link, it is imperative to first assess the effects and extent of genetic influence on such trait by comparing the phenotypic expression of the trait among relatives who expected would possess a high proportion (expression) of the gene for that trait even in successive generation. This is usually done through concordance or family correlation analysis.

As evident in the result, the high level of inheritance likelihood suggested that all variant types of palmar creases identified and studied had maternal and paternal contribution in palmar crease inheritance. This probably suggests that palmar crease is highly determine by genetic factor with little external influence. Pateria (1978) in exploration of the mechanism of inheritance of digito-dermal prints of Brahman populations of Central India, had earlier reported this finding. Similarly, the work of Karmakar *et al.* (2009), on the digito-palmar prints of 325 individuals of 104 families in Russia supported this argument. The same assertion about the genetic underpins of dermatoglyphics has also been reported by Lemza and Galaklionov (1982), Dar and Jaffe, 1983, Bharadwaja *et al.* (2004), Okoro and Uloneme (2005), Chauhan *et al.* (2011), Okoro (2015), Dar and Gul (2017), Meštrović and Ožegić (2017), and Hart and Otobo (2019).

But a breakdown of this in the two ethnic groups suggested that the inheritance or expression and non-expression (presence or absence) of middle longitudinal ceases had the highest level of inheritance likelihood (with low discordance) followed by shape of palmar crease and the least was pattern of origin/meeting of the three major creases (with high discordance when compared to others). The discordance observed points to the fact that other factors probably affect the inheritability of palmar creases. Thus, this study illustrated that the expression of palmar crease like other dermatoglyphic traits is via polygenic inheritance but there is more genetic contribution in its expression than these exogenous factors. This assertion agrees with the work of earlier researchers like Tay (1979) who posited that palmar crease could be a polygenic trait with high genetic contribution and less environmental influence; and Mathew and Satyanarayana, (1983) who noted that this trait did not conform to Mendelian inheritance model but that it is however genetically determined. This is also consistent with position of Omuruka *et al.* (2019) and Omuruka (2019) who expressly reported that fingerprints and lip prints were genetically determined but were inconsistent with Mendelian inheritance. Aigbogun *et al*. (2019) and Adekoya *et al*. (2020) have also supported the non-Mendelian fashion of some traits. In their respective study of toe length and its inheritance pattern among Nigerian populations they posited that not one locus of alleles (multiple genes) controls the inheritance of this trait.

Dominant pattern type

The phenotypic expression of palmar crease variants based on shape and presence of Middle longitudinal crease tend to suggest that these variants are controlled by two alleles respectively, and as such could be subjected to the dominant-recessive law/principle of Mendelian inheritance. Thus, using Mendelian Chi-square analysis to establish allelic dominance it was observed that Type M appears to be dominant over Type V among the Urhobo ethnic groups whereas among the Ogoni population the expression of Type V is dominant over Type M. Interestingly, the expression of Type Y (presence of middle longitudinal crease) proved to be dominant over Type X (absence of middle longitudinal crease) in the studied population except in the right palm of the Ogoni where Type X appeared slightly dominant over Type Y.

With the influence (dominance) of Type V over Type M (despite Type M being dominant over Type V among the Urhobo population) and slight influence of Type X over Type Y in the left palm among the Ogoni, it is suggestive that the expression of palmar creases exhibit what could be termed "alternating dominant-recessive pattern" (where a previously recessive variant type of trait exerts complete dominance over the initial dominant trait) which may be due to modulating effect of exogenous factors like the environment and others. This phenomenon could be a distinguishing feature of people in different environment. That is, as suggested by Omuruka *et al.* (2022a), this phenomenal discrepancy could be of forensic importance in establishing the different ethnic background and ancestry between these two ethnic groups, and thus may need to be explored among other ethnic groups/race as it may hold the clue to establishing ethnic/racial relationship or difference. This observation is similar to findings of Croxen *et al*. (2002) and Cooper *et al*. (2013), in their study of dominant-reccesive inheritance and penetrance, and Gwunireama and Ihemelandu (2010), in the study "Geographical influence on digit ratio (2D:4D): a case study of Andoni and Ikwerre ethnic groups in Niger delta, Nigeria", and Omuruka (2019) in the book "Genetics of Fingerprints and Lip prints: Inheritance pattern, Genetic Linkage and Gender Influence".

CONCLUSION

This study observed that the inheritance of pattern of origin (meeting pattern) of the three major creases is purely through polygenic expression while the inheritance of palmar crease shape and Middle longitudinal crease tend to suggest a di-allelic influenced expression respectively. However, the inheritance of palmar crease shape does not follow purely a dominant-recessive pattern (where one particular variant type constantly dominate the other) but rather follow what may be called "alternating dominant-recessive pattern" (where a previously recessive variant type of trait exerts complete dominance over the initial dominant trait) whereas, Middle longitudinal crease (Type Y/X) conform purely to a dominant-recessive inheritance pattern (with Type Y dominant over Type X).

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We write to state that all authors have contributed significantly, and that all authors are in agreement with the contents of the manuscript. 'Authors 1' (Omuruka T.C) designed the study protocol, wrote the first draft of the manuscript, examined the intellectual content of the manuscript; 'Authors 2' (Godson K.P) reviewed the design and protocol. All authors read and approved the final manuscript.

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