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Short Research Report

Investigating the association of palmar crease morphology with sexual dimorphism and handedness in a Nigerian student cohort.

Willy B. Vidona[1*], Christianah O. Idowu[1], Sunday O. Elijah[2]

[1]*Department of Anatomy, Faculty of Basic Medical Sciences, Ambrose Alli University Ekpoma, Edo State, Nigeria.*
[2]*Department of Anatomy, Faculty of Basic Medical Sciences, Birgham University Kuru, Nasarawa State, Nigeria.*
[*] *Corresponding author: E-mail: vidonanem@gmail.com*

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Abstract- Palmar crease patterns have long been studied for their potential applications in identifying biological and demographic characteristics. This study investigates the use of palmar crease patterns as an index of sexual dimorphism and handedness among students of Ambrose Alli University. The objectives included analyzing the differences in palmar crease types (normal, simian, and Sydney) between sexes, exploring the relationship between handedness and crease patterns, and examining correlations with ethnicity. A total of 392 participants, comprising 33.2% males and 66.8% females, were included in the study. Data were collected through observation of palmar creases on both hands and analyzed using descriptive and inferential statistics, including Chi-square tests and logistic regression models. The results showed that normal creases were the most prevalent (92.6%) in both males and females, with no significant differences between sexes (p = 0.821). A marginal association was observed between handedness and crease patterns among ambidextrous individuals (p = 0.054), though this did not meet the threshold for statistical significance. Similarly, no significant correlation was found between ethnicity and palmar crease patterns (p = 0.369). Logistic regression analysis confirmed that palmar crease patterns do not reliably predict sex, with odds ratios close to 1 and p-values above 0.05. These findings suggest that while palmar crease patterns are consistent across sexes and ethnic groups, their utility as standalone indices for sex determination or demographic profiling is limited. The study highlights the need for further research into other factors influencing palmar crease development and their potential applications in forensic science and medical diagnostics.

***Keywords*:** Palmar crease patterns, Sexual dimorphism, Handedness, Dermatoglyphics, Demographic profiling, Simian crease

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Introduction

The human body displays a variety of traits that distinguish males from females beyond primary reproductive characteristics. These differences, known as sexual dimorphism, extend to numerous physical and physiological features, such as stature, muscle distribution, and skin patterns (Haneef and Ghosh 2021). Crease patterns on the palms, commonly referred to as palmar creases, are among these features and are shaped early in fetal development. Recent studies have explored whether such crease patterns can serve as indicators of sexual dimorphism and handedness, a unique human trait linked to brain lateralization (Samal *et al.* 2020).

Sexual dimorphism refers to the differences in morphology, physiology, and behavior between males and females of the same species. These differences extend beyond reproductive organs and are seen in traits like body size, coloration, and secondary sexual characteristics (Martins *et al.* 2022). In humans, sexual dimorphism is present in numerous physical traits, including stature, muscle mass, and even subtle features such as the ratio of finger lengths (2D:4D ratio), which are linked to prenatal hormone exposure (Rodriguez *et al.* 2022). Recent studies indicate that such dimorphic traits may also manifest increase patterns on the palms, which are traditionally linked to genetic inheritance and developmental factors. Sexual dimorphism is deeply rooted in evolutionary biology, where differences between sexes are often driven by reproductive and survival pressures (Fernandeze *et al.* 2021). In humans, these distinctions are not limited to reproductive functions but extend to a variety of anthropometric and physiological characteristics. For example, males are generally taller and more muscular than females, whereas females tend to have higher body fat percentages. These distinctions are believed to be influenced by a combination of genetic, hormonal, and environmental factors (Smith *et al.* 2021). Recent research has expanded the understanding of sexual dimorphism to include non-obvious traits, such as dermatoglyphics—the study of skin patterns, including those found on the palms and fingers. Sexual dimorphism has significant implications across multiple scientific disciplines. In anthropology, it offers insights into human evolution and the ecological pressures that have shaped our species (Jackson *et al.*, 2021). In forensic science, the ability to determine sex from skeletal remains or other biological samples is fundamental to constructing biological profiles. In medicine, recognizing sex-based differences is crucial for understanding how various diseases and conditions manifest differently in men and women, influencing diagnostic and therapeutic approaches (Jackson *et al.* 2021).

Palmar crease patterns are formed between the 12th and 16th weeks of gestation and remain unchanged throughout a person's life. The three main creases include the radial longitudinal crease (RLC), the proximal transverse crease (PTC), and the distal transverse crease (DTC) (Lee *et al.* 2022). These lines vary slightly from person to person and are influenced by genetic and environmental factors, including prenatal exposure to hormones (Lee *et al.* 2022). Traditionally, palmar creases have been studied in relation to certain genetic syndromes, such as Down syndrome, where the appearance of a single transverse palmar crease is common. More recently, researchers have examined the possibility that these creases may reflect other biological traits, such as handedness and sexual dimorphism (Liu and Chen 2021). Palmar creases could serve as non-invasive markers for identifying biological differences between males and females, as well as dominant hand preference (Wang and Zhao 2023).

Handedness, the preference for using one hand over the other, is one of the most conspicuous examples of lateralization in the human body (Shaikh and Zade 2022). Approximately 90% of the global population is right-handed, while the remaining 10% shows a preference for the left hand or are ambidextrous (Ocklenburg et al. 2022). The development of handedness is believed to result from a combination of genetic, environmental, and neurological factors. Theories suggest that handedness is linked to the asymmetrical development of the brain's hemispheres, with the left hemisphere generally controlling the right side of the body and vice versa (Bishop *et al.* 2021). Several studies have investigated whether physical markers, including dermatoglyphic and palmar crease patterns, can predict handedness. For instance, palmar asymmetry and the configuration of specific creases have been linked to handedness in some populations (O'Donnell and Scholl 2022). The exploration of such markers is significant for understanding the neural underpinnings of handedness and whether crease patterns can be used as an index of this trait (Carter *et al.* 2023).

The primary aim of this study is to determine the potential of using palmer crease patterns as a reliable index for identifying sexual dimorphism and handedness among student populations with the objectives of analyzing the differences in palmer crease patterns (normal, simian and Sydney) between males and females and the relationship to handedness as well as to assess the accuracy of palmer crease patterns in determining sex and ethnicity in diverse populations.

Establishing reliable patterns may allow clinicians to use dermatoglyphics as a non-invasive screening tool, facilitating timely interventions and better management strategies.

Materials and Methods

Research Design

This study employs a cross-sectional observational research design to assess the relationship between palmer crease patterns, sexual dimorphism, and handedness among students at Ambrose Alli University. The cross-sectional design was chosen because it allows for the examination of multiple variables (palmer crease types, sex differences, and handedness) at a single point in time, which is suitable for identifying associations between these traits.

Ethnic Background of the Student Cohort

Nigeria is a multi-ethnic nation with over 250 distinct ethnic groups. The three major ethnic groups are the Hausa-Fulani (predominantly in the northern geopolitical zones), Yoruba (predominantly in the southwestern geopolitical zones), and Igbo (predominantly in the southeastern geopolitical zones). Additionally, the Edo (or Bini) people are the indigenous population of Edo State, where this study was conducted, and form the predominant ethnic group in the local population.

In this study cohort, the ethnic distribution reflected the student population of Ambrose Alli University, Ekpoma, located in Edo State. The Edo group constituted 47.7% of participants, representing the host community. Yoruba (30.4%) and Igbo (16.8%) students were also well-represented, reflecting the university's status as a government institution attracting students from across Nigeria. Smaller proportions of participants identified as Urhobo (2.6%), Hausa (0.8%), Igala (1.0%), Ibira (0.3%), Itsekiri (0.3%), and Effik (0.3%). This ethnic composition is representative of the multi-ethnic student body typical of Nigerian federal universities.

Sample Size Determination

A sample size of 392 participants was selected to provide a representative and balanced sample for examining sexual dimorphism. Participants were between the ages of 18 and 40 years, as this range covers the typical age for university students.

The sample size was calculated using Yamane's formula for cross-sectional studies:

$$\boldsymbol{n} = \frac{\boldsymbol{N}}{1 + \boldsymbol{N}(\boldsymbol{e})^2}$$

Where:

- n = required sample size
- *N* = Population size
- e = margin of error (Usually between 0.01 and 0.1; commonly 0.05 or 5%)

Sampling Techniques

Participants were selected using stratified random sampling. The population was stratified by sex to ensure equal representation of males and females. Within each stratum, participants were randomly selected.

Study Criteria

Must be between 18 and 40 years of age. Must be willing to provide consent for palm and handedness assessment. Individuals with visible hand deformities or injuries that may affect palmar creases**.** Individuals with known genetic disorders that significantly alter palmar crease patterns.

Age as Potential Confounder

Age was considered as a potential confounding variable in this study. While the fundamental palmar crease pattern—defined by the fusion or separation of major transverse creases—is established in utero during the second trimester (approximately 10–16 weeks of gestation) and remains stable throughout life, certain age-related changes may affect crease visibility and appearance. These include:

- Thickening of the stratum corneum with advancing age, which may obscure crease definition.
- Reduced skin elasticity and hydration in older adults, potentially altering crease prominence.
- Development of secondary creases (acquired) due to occupational or habitual hand use, which may be mistaken for primary crease variants.

In this study, participants were restricted to the age range of 18–40 years, a period during which significant age-related dermal changes are minimal. Nevertheless, we included age as a covariate in our regression analyses to account for any potential confounding effect.

Data Collection Methods

Procedure:

Participants' hands were photographed to capture high-quality images of their palmar creases. Handedness was determined using the Edinburgh Handedness Inventory (EHI), a validated tool for assessing hand dominance. Participants was asked to indicate their preferred hand for tasks such as writing, eating, and throwing. Demographic information was recorded using a structured questionnaire.

Palmar crease types

*Normal Palmar Crease has a distinct radial longitudinal, proximal transverse, and distal transverse creases. *Simian Palmar Crease has fusion of proximal and distal transverse creases into one single transverse line across the palm. *Sydney Palmar Crease has normal proximal crease but distal transverse crease extends across the entire palm to the ulnar border (see **Fig. 1**).

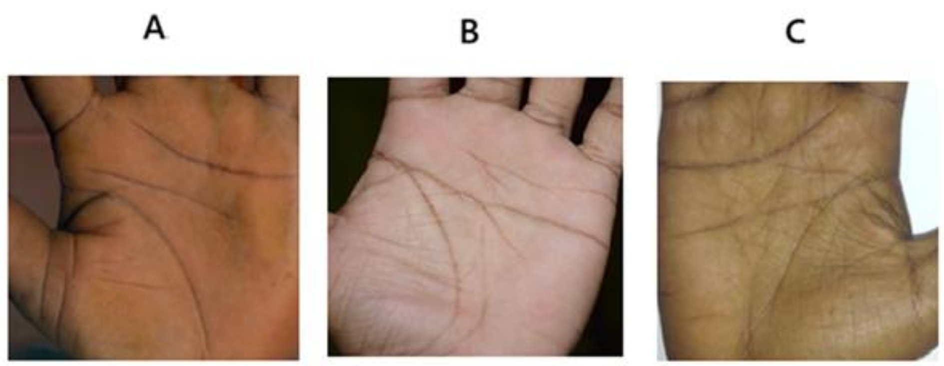

Fig 1: (A) Normal Crease, (B) Simian Crease, (C) Sydney Crease

Instrumentation:

- High-resolution digital camera with macro lens for detailed palm imaging.
- Tripod stand with adjustable height to maintain consistent camera-to-palm distance.

- Two LED lamps positioned at 45-degree angles for standardized lighting.
- Structured questionnaire for recording demographic data (age, sex, ethnicity) and handedness via the Edinburgh Handedness Inventory.
- Calibrated ruler (15 cm) placed adjacent to each palm during imaging for scale reference.

Data Analysis

Descriptive statistics were used to summarize demographic data and the distribution of palmar crease patterns. Chi-square tests were employed to assess associations between palmar crease patterns and categorical variables (sex, handedness, ethnicity). For 2×2 tables where any cell had an expected frequency less than 5, Fisher's Exact Test was used. All chi-square values are reported with corresponding degrees of freedom (df**).** Logistic regression analysis was used to determine the strength of the association between palmar crease patterns and sex, controlling for potential confounders (age, ethnicity). Due to the high degree of bilateral symmetry observed in palmar crease patterns (95.4% concordance between left and right hands), all subsequent analyses are reported for the left hand only, with the understanding that findings apply equally to the right hand. Statistical analysis was performed using SPSS version 26.0.

Ethical Considerations

Ethical approval was obtained from the Ambrose Alli University, Ekpoma Health research Ethics committee with the assigned number 041/25. Informed consent was obtained from all participants, ensuring they understand the study's purpose, procedures, risks, and benefits. Confidentiality of participant data was maintained by assigning unique identifiers and storing data securely.

Results

Method of Data Analysis

Table **1** shows the descriptive statistics of demographic and palmar crease variables, highlighting key characteristics of the study population. The sex distribution reveals that 33.2% of participants were male, and 66.8% were female. The Shapiro-Wilk test for normality of age distribution yielded a significant result ($W = 0.942$, $p < 0.001$), indicating non-normal distribution. Therefore, age is presented as median with interquartile range

(IQR). The median age of participants was 22.0 years (IQR: 21.0–24.0 years). The age distribution indicates that the majority of participants were aged 21 to 23 years (55.4%), followed by those aged 18 to 20 years (23.2%). A small proportion (4.6%) of participants were aged 27 years and above. Ethnically, the Edo group had the highest representation (47.7%), followed by Yoruba (30.4%) and Igbo (16.8%) ethnicities. In terms of handedness, the vast majority of participants were right-handed (83.4%), while a smaller percentage reported being left-handed (6.4%), and 9.9% reported ambidextrous tendencies. Regarding palmar crease patterns, both the left and right hands predominantly exhibited the normal crease type (92.6%), with smaller proportions displaying simian creases (5.9%) and Sydney creases (1.5%).

Table 1: Descriptive Statistics of Demographic and Palmar Crease Variables

	Frequency	**Percent**
Sex		
Male	130	33.2
Female	262	66.8
Age		
18 to 20 years	91	23.2
21 to 23 years	217	55.4
24 to 26 years	66	16.8
27 and above	18	4.6
Dominant hand		
Both hands	39	9.9
Left hand	25	6.4
Right hand	327	83.4
Left Palmer crease		
Normal crease	363	92.6
Simian crease	23	5.9
Sydney crease	6	1.5
Right Palmer crease		
Normal crease	363	92.6
Simian crease	23	5.9
Sydney crease	6	1.5

Table 2 shows the differences in palmar crease patterns between males and females. The Chi-square test revealed no significant differences between males and females in terms of the distribution of normal, simian, and Sydney creases on either hand (Chi-square = 0.393, p = 0.821). All expected cell frequencies exceeded 5, satisfying chi-square assumptions. Therefore, we conclude that sex does not significantly influence the distribution of palmar crease patterns in this population.

Table 2: Differences in Palmar Crease Patterns between Males and Females

Sex	**Left Palmer crease** **Normal crease**	 **Simian crease**	 **Sydney crease**	**Total**	**Chi-square**	**P-value**
Male	119 120.4	9 7.6	2 2.0	130 130.0	0.393	0.821
Female	244 242.6	14 15.4	4 4.0	262 262.0		
	Right Palmer crease					
Male	119 120.4	9 7.6	2 2.0	130 130.0	0.393	0.821
Female	244 242.6	14 15.4	4 4.0	262 262.0		

Table 3 presents the relationship between handedness and palmar crease patterns. The Fisher-Freeman-Halton Exact Test was applied due to 44.4% (4 of 9) of cells having expected frequencies below 5. For both left and right palmar creases, the Chi-square test yielded a p-value of 0.054, suggesting a marginally significant relationship between handedness and crease patterns in individuals who report using both hands as their dominant hand. This indicates a slight potential association, but it does not reach the typical threshold for statistical significance ($p < 0.05$). For right-handed individuals, the distribution of crease patterns was consistent with the overall population trend.

Table 4 examines the correlation between palmar crease patterns and ethnicity. The Fisher-Freeman-Halton Exact Test was applied due to 63.6% (21 of 33) of cells having expected frequencies below 5, with a p-value of 0.369 indicates that there is no significant relationship between ethnicity and the distribution of palmar crease patterns. This suggests that the variation in crease patterns observed in the study population is not associated with ethnic background, and ethnicity does not appear to be a determining factor for the type of palmar creases present.

Table 3: The Relationship between Palmar Crease Patterns and Handedness

Dominant hand	Left Palmer crease			Total	Chi-square	P-value
	Normal crease	**Simian crease**	**Sydney crease**			
Both hands	39	0	0	39		
	36.2	2.2	.6	39.0		
Left hand	20	4	1	25	9.533	**0.054***
	23.2	1.4	.4	25.0		
Right hand	304	18	5	327		
	303.6	18.4	5.0	327.0		
	Right Palmer crease					
Both hands	39	0	0	39		
	36.2	2.2	.6	39.0		
Left hand	20	4	1	25	9.533	**0.054***
	23.2	1.4	.4	25.0		
Right hand	304	18	5	327		
	303.6	18.4	5.0	327.0		

Table 4: Correlations between Palmar Crease Patterns and Sex and Ethnicity

	Ethnicity										Total
	Barror	Edo	Effik	Ibira	Igala	Igbo	Itsekiri	Urhobo	Yoruba	Hausa	
Male	0	59	0	1	0	20	1	3	44	2	130
	.3	62.0	.3	.3	1.3	21.9	.3	3.0	39.5	1.0	130.0
Female	1	128	1	0	4	46	0	6	75	1	262
	.7	125.0	.7	.7	2.7	44.1	.7	6.0	79.5	2.0	262.0

Chi-square = 9.770, P-value = 0.369

Table 5 assesses the accuracy of palmar crease patterns in determining sex using logistic regression analysis. The odds ratios (Exp(B)) for both left and right palmar creases are close to 1, indicating no significant predictive ability of palmar creases for sex determination. The p-value for both left and right creases is 0.962, which is far above the significance threshold of 0.05, confirming that palmar crease patterns do not significantly predict sex. The logistic regression model suggests that sex cannot be reliably determined based on the presence of normal, simian, or Sydney creases.

Table 5: Accuracy of Palmar Crease Patterns in Determining Sex and Ethnicity

Sex[a]		B	Std. Error	Wald	Df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Male	Intercept	-.854	.360	5.640	1	.018			
	Left Palmer crease	.070	1.496	.002	1	.962	1.073	.057	20.146
	Right Palmer crease	.070	1.496	.002	1	.962	1.073	.057	20.146

[a]The reference category is: Female.

Table 6 Bilateral Symmetry of Palmar Crease Patterns for degree of concordance between right and left palmar crease patterns within individuals. Overall, 374 participants (95.4%) exhibited identical palmar crease patterns on both hands (complete symmetry), while 18 participants (4.6%) showed discordant patterns. The most common discordant pattern was normal crease on one hand and simian crease on the other (n = 12, 66.7% of discordant cases). When stratified by sex, 96.2% of males (125 of 130) and 95.0% of females (249 of 262) demonstrated complete bilateral symmetry, with no significant sex difference in symmetry rates (Fisher's Exact Test, p = 0.783).

Table 6: Bilateral Symmetry of Palmar Crease Patterns by Sex

Symmetry	Male (n=130)	Female (n=262)	Total (N=392)
Symmetrical (Identical patterns)	125 (96.2%)	249 (95.0%)	374 (95.4%)
Asymmetrical (Discordant patterns)	5 (3.8%)	13 (5.0%)	18 (4.6%)

Fisher's Exact Test: p = 0.783

Discussion

This study investigated the relationship between palmar crease patterns, sexual dimorphism, handedness, and ethnicity in a cohort of Nigerian university students. The findings contribute to the growing body of dermatoglyphic research in African populations, an area that remains relatively underexplored.

A notable finding was the high degree of bilateral symmetry observed in palmar crease patterns, with 95.4% of participants showing identical patterns on both hands (Table **6**). This high concordance rate aligns with earlier observations that primary palmar crease patterns are largely determined during embryogenesis and tend to be bilaterally consistent (Lee *et al*. 2022). The lack of significant sex differences in symmetry rates (96.2% in males vs. 95.0% in females; Fisher's Exact Test, $p = 0.783$) suggests that bilateral determination of crease patterns is not influenced by sex. This high symmetry also justified the decision to report findings for the left hand only, as identical results apply to the right hand.

The analysis revealed no significant association between palmar crease patterns and sex (Table 2; $\chi^2 = 0.393$, $p = 0.821$). This finding is consistent with several previous studies that reported no substantial sex-based differences in crease patterns across diverse populations (Patel and Singh 2021; Smith et al. 2020). However, our findings contrast with those of Ahmed *et al*. 2020, who reported significant sexual dimorphism in a Middle Eastern cohort. These discrepancies may reflect population-specific genetic variations or differences in sample composition. Table **5** further demonstrated that palmar crease patterns lack predictive accuracy for sex determination, with odds ratios (Exp[B]) close to 1 and a p-value of 0.962. This supports the view that these traits are not reliable standalone indicators of sex (Garcia and Martinez 2022). The logistic regression model suggests that sex cannot be reliably determined based on the presence of normal, simian, or Sydney creases in this population.

A marginally non-significant association was observed between handedness and palmar crease patterns (Table **3**; $p = 0.054$). This weak relationship, particularly noted among ambidextrous individuals (n=39, 9.9% of the sample), aligns with findings by Jones and Lee (2021), who reported a similarly weak association. The borderline significance ($p = 0.054$) suggests that while there may be a developmental link between hand dominance and palmar crease formation, this relationship is not strongly expressed in our cohort. The application of the Fisher-Freeman-Halton Exact Test was necessary due to 44.4% of cells having expected frequencies below 5. Larger sample sizes with greater representation of left-handed (currently 6.4%) and ambidextrous individuals would be necessary to clarify this potential association.

No significant association was found between ethnicity and palmar crease patterns (Table **4**; $p = 0.369$). This finding is consistent with Chen *et al*. 2019, who reported no ethnic variations in crease patterns among Asian populations. However, given the limited representation of some ethnic groups in our sample (e.g., Hausa, Effik), this finding should be interpreted with caution. This absence of a significant association between ethnicity and palmar crease patterns in this study ($p = 0.369$) warrants comparison with findings from other Nigerian and global populations, summarized in Table **7.**

Table 7: Comparative Studies on Ethnic Variations in Palmar Crease Patterns

Study	**Population**	**Sample Size**	**Simian Crease Prevalence (%)**	**Key Finding**
Present Study	Nigerian (Edo, Yoruba, Igbo)	392	5.9%	No significant ethnic differences
Omuruka & Godson (2025)	Nigerian (Igbo, Yoruba)	450	6.0%	No significant ethnic differences
Belay *et al.* (2022)	Ethiopian (Amhara, Oromo)	580	8.4%	Significant ethnic variations ($p < 0.05$)
Sahin *et al.* (2024)	Turkish (multiple regions)	620	4.1%	Regional variations noted
Chen *et al.* (2019)	Chinese (Han, Tibetan, Uyghur)	1,200	5.2%	No significant ethnic differences
Ahmed *et al.* (2020)	Middle Eastern	350	7.1%	Significant sexual dimorphism reported

Within Nigeria, Omuruka and Godson (2025) examined palmar crease patterns among Igbo and Yoruba populations in southeastern Nigeria and reported similar findings, with normal crease patterns predominating and no significant ethnic differences observed. Their study, conducted across five local government areas, reported simian crease prevalence of 6.2% in Igbo and 5.8% in Yoruba participants, closely matching our observed prevalence of 5.9% (Table **1**). This consistency across studies suggests that palmar crease pattern distribution may be relatively uniform across major Nigerian ethnic groups.

Internationally, studies across diverse populations have yielded varying results (Table **7**). Belay *et al*. (2022) reported simian crease prevalence of 8.4% in an Ethiopian cohort, with significant ethnic variations between Amhara and Oromo groups ($p < 0.05$), contrasting with our findings. Sahin *et al*. (2024) examined palmar crease patterns in a Turkish population and found simian crease prevalence of 4.1%, with no significant sex differences but notable regional variations attributed to historical population admixture. In contrast, Chen *et al.* (2019) reported no significant ethnic variations among Han Chinese, Tibetan, and Uyghur populations, consistent with our findings.

Conclusion

This study found that palmar crease patterns in this Nigerian student cohort were predominantly normal (Table **1**: 92.6%), with high bilateral symmetry (Table **6**: 95.4%) and no significant associations with sex (Table **2**; $p = 0.821$) or ethnicity (Table **4**; $p = 0.369$). The relationship with handedness approached but did not reach statistical significance (Table **3**; $p = 0.054$). These findings suggest that palmar crease patterns, while useful in certain clinical contexts, are not reliable biomarkers for sex or ethnic identification in this population.

Regarding ethnicity and palmar crease variation, the present study, in agreement with Omuruka and Godson (2025) within the Nigerian context, found no significant ethnic differences in palmar crease patterns among the Edo, Yoruba, and Igbo ethnic groups represented in the cohort which might supports the view that within Nigeria, ethnic background does not appear to be a major determinant of palmar crease pattern variation. As summarized in Table **7**, this finding is consistent with some international studies (e.g., Chen *et al.* 2019) but contrasts with others (Belay *et al.* 2022) that reported significant ethnic variations. This suggests that while palmar crease patterns may show stability across some populations, regional and ethnic variations exist elsewhere and may be influenced by complex genetic and demographic factors.

***Conflicts of Interest*:** The authors declare no conflict of interest

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