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# FOREHEAD WRINKLE PATTERNS AMONG ADULT RESIDENTS IN SOUTH-WEST NIGERIA

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***Abstract***

*Facial landmarks, including wrinkle patterns, are valuable tools in forensic science for individual identification, particularly in criminal investigations. This study explores forehead wrinkle patterns among Yoruba adults residing in Southwest Nigeria, with potential applications in forensic anthropology and aesthetic profiling. Eighty participants, 51 males and 29 females, were recruited. Facial wrinkles were documented while subjects sat upright, facing forward in the Frankfort plane. Variables assessed included glabellar vertical wrinkles, horizontal forehead wrinkles, lateral intercanthal distance, medial inner canthal distance, glabella-to-hairline distance, body mass index (BMI), and body surface area (BSA). Facial images were captured using a Nikon D-60 camera positioned one meter away on a tripod. Findings revealed that forehead wrinkle patterns among Yoruba adults are individually distinctive and categorised into two types: horizontal and vertical. Horizontal wrinkles presented in eight distinct patterns, while vertical wrinkles exhibited five. The most prevalent pattern among males was Few Shallow Wrinkles (FSW), whereas females predominantly showed Few Deep Wrinkles (FDW). These patterns were not only unique to each individual but also*

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Vol: 63 | Issue: 02 | 2026

*showed gender-based variation. The study highlights the potential of forehead wrinkle analysis as a biometric marker for identification and contributes novel data to the field of forensic science in Africa. To the best of our knowledge, this is the first documented analysis of forehead wrinkle typology in Nigeria and sub-Saharan Africa. The dataset generated offers a foundational reference for future research in regional forensic profiling, dermatological studies, and cultural aesthetics.*

***Keywords:*** *Wrinkles, Facial Identification, Ageing Pattern, Facial Aesthetic, Southwest Residents, Nigeria.*

## 1. INTRODUCTION

Forehead wrinkles can be referred to as fibrosis of the forehead skin caused by the accumulation of improper repairs of injured elastic fibres and collagen fibres (Bonté *et al.,* 2019). It can also be referred to as folds, ridges or creases in the skin (Lee *et al.,* 2021). According to Chaudhary (2020), wrinkles of the skin are defined as creases limited to the dermal layer, which can be cosmetically treated; they may last for a short while or a longer period. The changes that occur on an individual's body as they age are seen for a short period of time or longer on facial skin, as wrinkling takes a slow period of time to manifest in an individual's lifetime (Chalise, 2019; Zargaran *et al*., 2022). The significant occurrence of wrinkles is a pointer that shows that the skin's ''Recovery Ability'' has declined continuously with age.

Forehead wrinkling is a special biological occurrence, shown as chronological wrinkling and sunlight-induced wrinkling, which is controlled by intrinsic factors and extrinsic factors. Because of the fast growth of medicine in promoting human longevity and the speedy growth of environmental degradation, it is imperative to look for better and acceptable methods to handle skin wrinkles and promote conditions for the patterning of wrinkles.

Food, as the major route for the body to gain nutrients, has slowly seen its efficacy for skin health (Changwei *et al*., 2020). What to eat to remain fresh and maintain healthy skin has always been the goal of humans, considering a balanced diet and its efficacy in skin wrinkling. How to maximise healthy skin and slow wrinkling is now one of the most attractive topics people like to engage with (Changwei *et al*., 2020). Therefore, in this research, we looked at the forehead wrinkle structures, ageing manifestations, possible mechanisms of socio-demography and anthropometry patterning of wrinkles. Forehead wrinkling is now a worldwide challenge because it is connected to beauty, societal appeal, and wealth (Frevert, 2014). This has been noted as a major task in world skin health by the International League of Dermatological Societies (Blume-Peytavi *et al*., 2016).

Though the belief and manifestation of skin wrinkling is not the same for all ethnicities. Ways of life alongside underlying regional skin uniqueness may cause variations in skin health and appearance. Promoting forces can be variations in anatomy, constitution, building, nutrients, and uses of the skin of different people (Vashi, 2016; Flament, 2015; Raj *et al*., 2016). Also, wrinkling varies among various cultural groups, which can be because of irregularity in biological determining factors depending on geographic location (Vierkotter *et al*., 2016). These, alongside behavioural habits, are reasoned to be cogent wrinkling components that contribute to skin wrinkling. To prevent societal-specific wrinkling events and undesired wrinkles, knowing cultural variation in tegument built and clues to wrinkling is cardinal. Many agreed that the onset of wrinkling begins sooner in less dark-skin individuals than in more darkly individuals (Krutmann *et al.*, 2016). The major cause is the higher built-in UV-shelter of darkly colour skin, but the unit and biology performance are torturous (Krutmann *et al.*, 2016).

The Morphometrics of the face play a key role in aesthetic medicine, as it has been recorded that the superior 1/3 of the face shows an essential role in good looking (Deschamps-Braly, 2018). Males and females have unique attributes of the superior 1/3 of the face that determine surface investigation

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Vol: 63 | Issue: 02 | 2026

and aim at face-lift procedures, sex face-lift procedures, and hair repositioning. The shape hairline and forehead is unique in males and females (Deschamps-Braly, 2018). Practically, males have an M-shape hairline with different degrees of frontotemporal concavity (Toledo *et al*., 2017). Before now, it was believed to be always apple-shaped; the women's hair boundary is unique from males and has been seen to be more unlikely; about 81% of females have a widow’s style, 98% have lateral temporal hillock, while 64% have cowlick style. Men's forehead shows a larger supraorbital and glabella rim, but the contour of women's foreheads is smoother with more impalpable bony landmarks (Toledo *et al*., 2017).

Spiegel (2011) opined that the strongest association of forehead feminisation is the femininity of the whole face if considered with the feminisation process of the middle or inferior face. Spiegel (2011) also considered craniometric point prominence, brow structure and posture, and hair boundary nature as the major factors that define the facial upper 1/3. This revelation has clearly shown why forehead features of an individual, especially those of females, serve as an important site for aesthetics. Body reference areas are non-invasive numeric measurements of the body. The most commonly used, generally accepted, cheap, and non-invasive technique for evaluating the size, dimension, and makeup of the individual's structure is provided by Anthropometry. It shows both well-being and biological process state and foretell operation, well-being, and life expectancy. As stated by the Centres for Disease Control and Prevention (CDC) (2022), the valuable appraisal of nutritional status in young and older people can be achieved with anthropometry.

The facial wrinkle assessment scale was developed by forensic scientists as a tool for assessment of changes resulting from contraction of facial muscles (Lemperle *et al*., 2001). Horizontal forehead wrinkle and vertical Glabella wrinkle are the two most common types of forehead facial wrinkling in human subjects (Hajimahmoudi *et al*., 2018). The two major types of wrinkles normally appear on different individuals based on the degree of prevailing factors in such an individual, as shown in Figure 1 below.

**Classification Model of Facial Wrinkles**

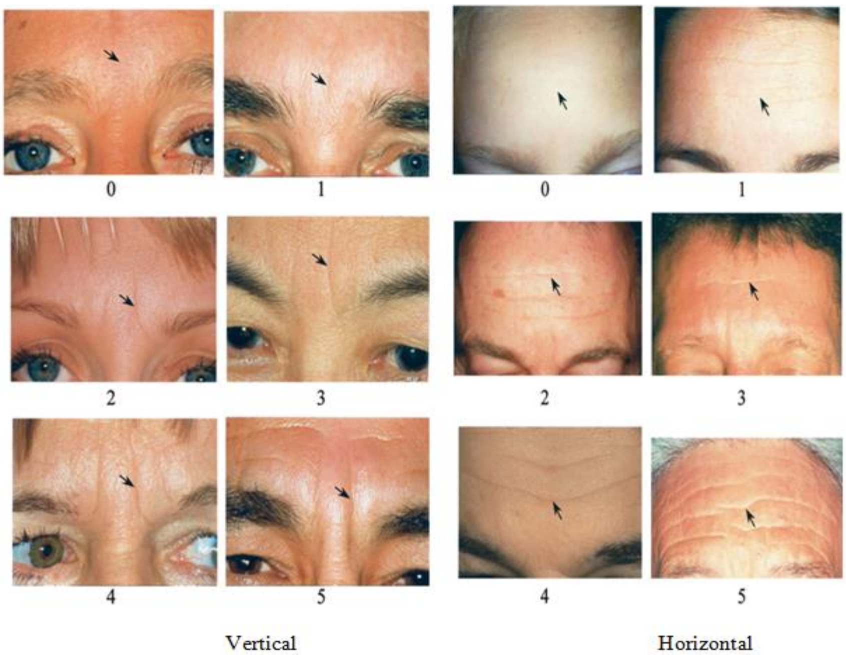


**Figure 1: Diagram showing the degree of wrinkle formation, starting from 0-5 degrees of both Vertical and Horizontal Forehead Lines (Döhler, von Ribbeck, Fidorra, Felke, & Geissler, 2020)**

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

The soft tissues are draped on the bones of the forehead, forming the scaffold. The anterior surface, which is convex, is presented by the frontal bone anteriorly. At the coronal suture, it articulates with (i) the parietal bones posteriorly, (ii) anteriorly and medially, the nasal bones and the frontal process of the maxilla, (iii) at the frontozygomatic suture laterally, the frontal process of the zygoma, and (iv) the greater wing of the sphenoid within the temporal fossa. Orbital surface and an intracranial surface are also present on the frontal bone (Netter, 2019).

## 2. MATERIALS AND METHODS

### 2.1 Subject Population

A total of eighty (80) human subjects within the age bracket of 18 and 60 years, consisting of fifty-one (51) males and twenty-nine (29) females with no form of forehead mutilation, forehead makeup, forehead mask, and non-pregnant women, were recruited for this research.

### 2.2 Study Area

This human study was conducted at the College of Medicine and Health Sciences of Afe Babalola University, Ado-Ekiti, Southwest, Nigeria. The study took place between 5th January 2022 and 7th November 2022.

### 2.3 Ethical Approval

This study adhered to the Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects, adopted by the 18th WMA General Assembly, Finland, June 1964, and amended by the 64th WMA General Assembly, Fortaleza, Brazil, October 2013.

The study was approved by the local Research and Ethics Committee of College of Medicine and Health Sciences, Afe Babalola University, with ethical numbers ABUADHREC/12/06/2022/66. Volunteers gave their informed consent to participate in the study.

### 2.4 Data Collection

A convenient purposive sampling method was used, i.e., moving around searching for individuals with wrinkle features. The subjects were recruited using the consent form and questionnaire requesting their demographic information. The reason for convenient selection is to ensure accuracy and unbiased judgment during the period of recruitment.

### 2.5 Protocol

The facial wrinkles of the subjects were captured when the subjects' foreheads were positioned in an erect sitting position to prominently show the wrinkling pattern of the forehead. The following variables were assessed: Horizontal forehead pattern, glabella vertical wrinkle pattern, lateral intercanthal distance, medial intercanthal distance, and glabella hairline distance.

Because of credibility and reliability Nikon D 60 model camera was used to snap those features of the subjects at a distance of one meter on tripod stand, with Max aperture of 3.6, Dimension of 3872 x 2592, Resolution of 300dpi, F-stop: f/6.3, Exposure time 1/100sec, iso speed 800, Exposure bias +0.3, focal length of 1:3.6, Flash mode: flash, auto, Strobe return 35mm focal length 27 was used respectively. The subjects sat in an erect position, while looking forward in the Frank-forth plane as shown in Figure 2 below.

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

**Facial Wrinkle Pattern during the Research**

**Figure 2: Using a Nikon D60 Model Camera to snap the Facial Wrinkle Pattern during the research, as the subject sat in an Erect Position**

**2.5.1 Facial recognition software**

For the assessment of pictures of the forehead wrinkles from the images of the subjects, an advanced, reputable Corex X3 Adobe software was used to analyse the pictures obtained for this research to ensure an accurate assessment of the wrinkle patterning.

**2.5.2 Estimation of Anthropometric Measurement Parameters**

**a. Body mass index (BMI)**

This was achieved by converting the height (H), which was measured in centimetres, to meters, followed by squaring the outcome of the conversion. The formula for BMI estimation is mathematically represented below:

$$BMI = \frac{\text{Weight in kilograms}}{\text{Height in metressquare}} \text{kg/m}^2$$

This means that the various heights in square meters (m$^2$) and weights in kilograms (kg) of all the subjects were used to generate their corresponding BMI.

**b. Body surface area (BSA)**

In this study, BSA was calculated by using an abridged version of the one designed by Gehan and George (1970), known as the Moseller formula. It is mathematically represented below:

$$\text{BSA} = \sqrt{\frac{\text{Weight (kg)} \times \text{Height (cm)}}{3600}}$$

Where 3600 is constant as reported by (Laurenz *et al*., 1997). Both BMI and BSA were calculated with the aid of a simple Casio calculator.

**c. Height**

The height of the subjects was measured with the use of the most advanced reputable Seca 213 portable stadiometer. The subjects were encouraged to stand on bare feet to ensure an accurate result. The measurements were taken while the subjects were standing in their Anatomical position.

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

**d. Weight**

The body weights of the subjects were measured with the aid of an advanced, reputable Axiom-body weighing scale. The subjects were encouraged to put on wear that has no significant weight and to stand barefoot to ensure an accurate result. The measurement was taken while the subject was standing in their Anatomical position.

**Data Analysis**

The data for this study were analysed using the latest version of IBM SPSS (V.23) software. Both descriptive and inferential statistics were used to estimate some basic parameters of the study. The correlation coefficient was used to test the relationship between variables, while analysis of variance was used to determine variables with similarities in their means or otherwise. Statistical test of independence was performed using the Student t-test. Data were expressed as mean ± standard deviation (SD). The significance level of this study was set at below 0.05.

## 3. RESULT

### 3.1 Horizontal Facial Wrinkle Assessment

This result shows the pattern of horizontal facial wrinkles in Southwestern Nigeria and the types of Facial Horizontal Wrinkles Discovered (Few Lines = Number of lines below 5; Many Lines = 5 lines and above).

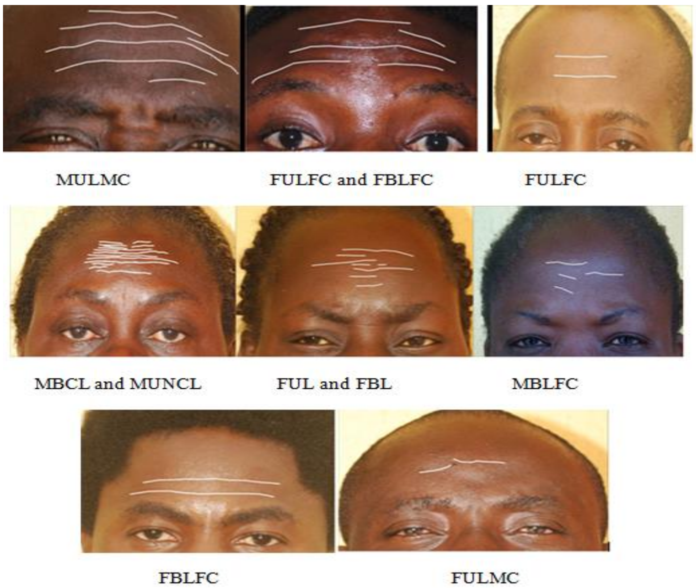


**Figure 3**

Figure 3 was developed by the authors

**Figure 3**: Parameters for Horizontal facial wrinkle assessment. The discovered wrinkle patterns are as follows:

a) Many unbroken lines with many curves (MULMC)

b) Few unbroken lines with few curves and few broken lines with few curves (FULFC and FBLFC)

c) Few unbroken lines with few curves (FULFC)

d) Many broken curved lines and many unbroken curved lines (MBCL and MUCL)

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Vol: 63 | Issue: 02 | 2026

e) Few unbroken lines and few broken lines (FUL and FBL)

f) Many broken lines with few curves (MBLFC)

g) Few broken lines with few curves (FBLFC)

h) Few unbroken lines, many curves (FULMC).

**Table 1: Showing the Frequency of the Various Types of Horizontal Wrinkles**

This table shows the Parameters for Horizontal facial wrinkles assessed in this study, as stated in Figure 3 above, with the percentage and frequency of each wrinkle pattern.

| Types of horizontal wrinkle | Frequency | Percentage (%) |
|---|---|---|
| Many unbroken lines, many curves (MULMC) | 8 | 10.0 |
| Few unbroken lines, few curves (FULFC) | 14 | 17.5 |
| Few unbroken lines few curves (FULFC) and few broken lines, few curves (FBLFC) | 6 | 7.5 |
| Many broken lines Few curves (MBLFC) | 18 | 22.5 |
| Few broken lines few curves (FBLFC) | 20 | 25.0 |
| Many broken curve lines (MBCL) and many unbroken curve lines (MUCL) | 7 | 8.8 |
| Few unbroken lines (FUL) and few broken lines (FBL) | 5 | 6.2 |
| Few unbroken lines, many curves (FULMC) | 2 | 2.5 |
| Total | 80 | 100.0 |

Table 1, developed by the authors

FBLFC had the highest frequency of 20 (25%), which is followed by MBLFC with a frequency of 18 (22.5%). FULFC presented a frequency of 14 (17.5%), and MULMC was shown to have a frequency of 8 (10%). MBCL and MUCL, FUL and FBL, FULFC and FBLFC, and FULMC had a frequency of 7 (8.8%), 5 (6.2%), 6 (7.5%), and 2 (2.5%), respectively.

**3.2 Frequency for Before and After the Analysis of Facial Wrinkles**

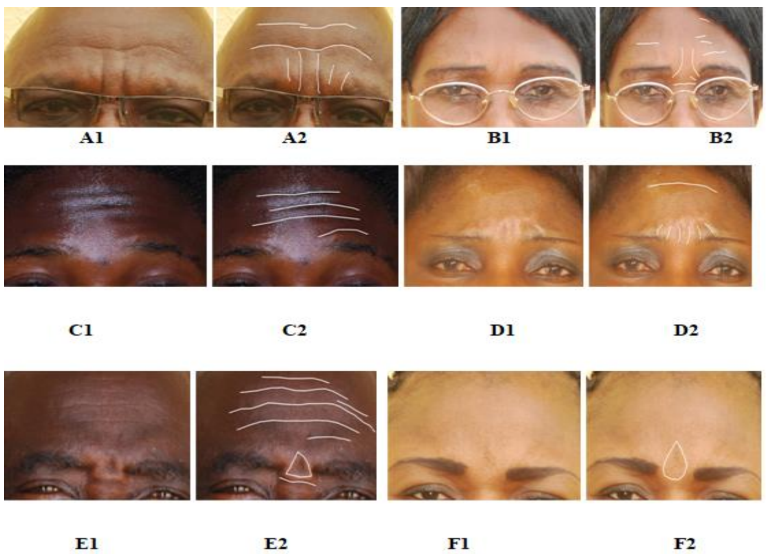


**Figure 4: Showing frequency for Before and After the Analysis of Facial Wrinkles 1. A1-Before analysis, 2. A2-After analysis, 3.B1- Before analysis, 4. B2-After analysis, C1-Before analysis, C2-After analysis, D1-Before analysis, D2-After analysis, E1-Before analysis, E2-After the analysis, F1-Before analysis, F2-After analysis**

ISSN：1674-2974 | CN 43-1061 / N

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

Figure 4: developed by the authors

**Table 2: Frequency of horizontal wrinkle by gender**

| Gender | Type of horizontal wrinkle | Frequency | Percentage (%) |
|---|---|---|---|
| **Male** | **MULMC** | 5 | 9.8% |
| | **FULFC** | 9 | 17.6% |
| | **FULFC and FBLFC** | 4 | 7.8% |
| | **MBLFC** | 7 | 13.7% |
| | **FBLFC** | 16 | 31.4% |
| | **MBCL and MUCL** | 6 | 11.8% |
| | **FUL and FBL** | 2 | 3.9% |
| | **FULMC** | 2 | 3.9% |
| | **Total** | 51 | 100.0% |
| **Female** | **MULMC** | 3 | 10.3% |
| | **FULFC** | 5 | 17.2% |
| | **FULFC and FBLFC** | 2 | 6.9% |
| | **MBLFC** | 11 | 37.9% |
| | **FBLFC** | 4 | 13.8% |
| | **MBCL and MUCL** | 1 | 3.4% |
| | **FUL and FBL** | 3 | 10.3% |
| | **FULMC** | 0 | 0.0% |
| | **Total** | 29 | 100.0% |

Table 2, developed by the authors

Table 2 results indicated that in males, FBLFC had the highest frequency of 16 (31.4%). The FULFC presented a frequency of 9 (17.6%), MBLFC 7 (13.7%), MBCL and MUCL 6 (11.8%), and MULMC 5 (9.8%). FULFC and FBLFC, FUL and FBL, and FULMC were shown to have 4 (7.8%), 2 (3.9%), and 2 (3.9%), respectively.

This study revealed from the results in Table 9 that females do not have FULMC, but there was an occurrence of MBLFC with the highest frequency of 11 (37.9%), followed by FULFC with a frequency of 5 (17.2%). FBLFC had a frequency of 4 (13.8%), MULMC 3 (10.3%), FUL and FBL 3 (10.3), FULFC and FBLFC 2 (6.9%) and MBCL and MUCL 1 (3.4%).

### 3.3 General Subject Grouping According to Facial Wrinkle Pattern

The subjects were grouped into three categories based on the assessment of the wrinkling pattern of the subject for proper evaluation.

a) Fine, ill-defined wrinkles pattern

b) Fine-to-moderately deep wrinkles and a moderate number of lines.

c) Fine-to-deep wrinkles, numerous lines, and possibly redundant folds

#### 3.3.1 Wrinkle Pattern Matching

In this section, we assessed the similarity between two wrinkle patterns using:

a) Unbroken fine line with many curve patterns.

b) Fine broken lines with few curve patterns.

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Vol: 63 | Issue: 02 | 2026

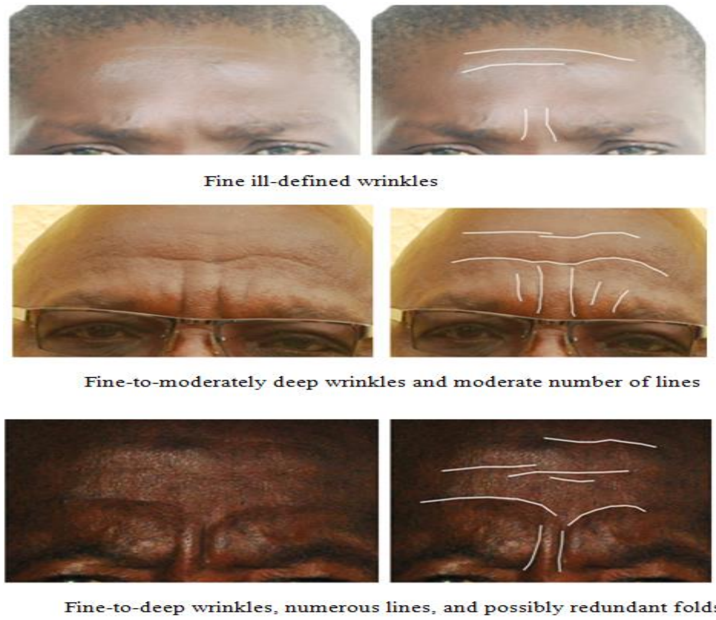


**Figure 5: Subject Grouping according to Facial Wrinkle Pattern**

Figure 5: developed by the authors

### 3.4 Vertical Wrinkles Discovered Assessment

This result shows the pattern of vertical facial wrinkles in Southwestern Nigeria and the types of vertical facial wrinkles discovered (Few Lines = Number of lines below 5; Many Lines = 5 lines and above).


**Figure 6**

Figure 6: developed by the authors

**Figure 6**: Different Vertical Facial Wrinkles discovered. The discovered wrinkle patterns are as follows:

a) Few shallow wrinkles (FSW)

b) Many shallow wrinkles (MSW

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

c) Many deep wrinkles (MDW)

d) Few deep wrinkles (FDW)

e) Centre pit wrinkle (CPW)

f) No vertical wrinkle (NVW)

**Table 3: showing the frequency of the various types of vertical wrinkle**

This table shows the Parameters for vertical facial wrinkle assessed for males and females in this study, as stated in Figure 4 above, with the percentage and frequency of each wrinkle pattern.

| Gender | Types of vertical Wrinkle | Frequency | Percentage (%) |
|---|---|---|---|
| Male | **FSW** | 15 | 29.4% |
| | **MSW** | 3 | 5.9% |
| | **MDW** | 5 | 9.8% |
| | **FDW** | 15 | 29.4% |
| | **NVW** | 12 | 23.5% |
| | **CPW** | 1 | 2.0% |
| | **Total** | 51 | 100.0% |
| Female | **FSW** | 14 | 48.3% |
| | **MSW** | 2 | 6.9% |
| | **MDW** | 0 | 0.0% |
| | **FDW** | 3 | 10.3% |
| | **NVW** | 10 | 34.5% |
| | **CPW** | 0 | 0.0% |
| | **Total** | 29 | 100.0% |

Table 3, developed by the authors

Table 3 results specified that among males, FSW and FDW had the highest frequency of 15 (29.4%) each. Subjects with NVW presented a frequency of 12, which accounted for 23.5%, while subjects with CPW had a frequency of 1 and accounted for 2.0%. In addition, MSW and MDW had a frequency of 3 (5.9%) and 5 (9.8%), respectively, for the male subjects. While for the female subject, MDW and CPW have a frequency of 0, which accounted for 0% of the subjects, respectively. FSW showed a frequency of 14 (48.3%) while NVW and FDW had a frequency of 10 (34.5%) and 3(10.3%), respectively.

**Frequencies of the Various Types of Variables**

**Table 4: Showing the descriptive statistics of the variables of the sampled populations**

This table shows the maximum and minimum limits of various variables measured from the population of subjects used for this study, as stated in the 2.5 'study protocol' of this work.

| Variables | N | Minimum | Maximum | Mean ± SD | SEM |
|---|---|---|---|---|---|
| Age (years) | 80 | 27.00 | 75.00 | 43.96±9.98 | 1.12 |
| Height (m) | 80 | 1.34 | 2.16 | 1.73±0.10 | 0.01 |
| Weight (kg) | 80 | 51.00 | 84.00 | 66.45±7.97 | 0.89 |
| Body mass index ($kg/m^2$) | 80 | 13.92 | 35.65 | 22.12±3.12 | 0.34 |
| Body surface area ($m^2$) | 80 | 0.02 | 0.20 | 0.02±0.02 | 0.00 |
| Medial canthal distance (cm) | 80 | 1.02 | 1.70 | 1.36±0.13 | 0.01 |
| Lateral intercanthal distance (cm) | 80 | 3.08 | 4.80 | 3.89±0.34 | 0.04 |
| Glabella hair line distance (cm) | 80 | 1.81 | 2.90 | 2.30±0.23 | 0.03 |

Table 4 was developed by the authors

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Vol: 63 | Issue: 02 | 2026

**Table 4:** showed that the age of the sampled population ranged 27-75, while that of the height, weight, body mass index, body surface area, medial canthal distance, lateral inter canthal distance and glabella hair line distance ranged 1.34-2.16, 51-84, 13.92-35.65, 0.02-0.20, 1.02-1.70, 3.08-4.80 and 1.81-2.90 respectively. The mean ± SD of age, height, weight, body mass index, body surface area, medial canthal distance, lateral intercanthal distance and glabella hair line distance was 43.96±9.98, 1.73±0.10, 66.45±7.97, 22.12±3.12, 0.02±0.02, 1.36±0.13, 3.89±0.34 and 2.30±0.23, respectively.

**Table 5: Showing the correlation between the height, weight, BMI, BSA and age with Medial canthal distance, Lateral intercanthal distance and Glabella hairline distance for the sampled population**

This table is concerned with the comparative correlation of some groups of variables stated in Table 3 above; it shows the degree of p-value correlation among them.

| | | Height (m) | Weight (kg) | BMI ($kg/m^2$) | BSA ($m^2$) | Age (yrs) |
|---|---|---|---|---|---|---|
| Medial canthal distance (MCD) (cm) | Pearson Correlation (r) | 0.16 | 0.02 | -0.18 | -0.10 | 0.14 |
| | p-value | 0.16 | 0.83 | 0.12 | 0.36 | 0.22 |
| | N | 80 | 80 | 80 | 80 | 80 |
| Lateral intercanthal distance (LID) (cm) | Pearson Correlation (r) | 0.02 | 0.08 | -0.07 | -0.08 | 0.05 |
| | p-value | 0.83 | 0.51 | 0.55 | 0.49 | 0.67 |
| | N | 80 | 80 | 80 | 80 | 80 |
| Glabella hairline distance (GHD) (cm) | Pearson Correlation (r) | 0.02 | -0.06 | -0.10 | -0.21 | -0.02 |
| | p-value | 0.85 | 0.63 | 0.36 | 0.06 | 0.84 |
| | N | 80 | 80 | 80 | 80 | 80 |

Table 5 was developed by the authors

These results show that there was no significant relationship between the parameters. Glabella hairline distance has a negative correlation that is not significant with weight, age, BMI and BSA. It also has a positive correlation with height, which is not significant.

**Table 6: Showing the descriptive statistics of the variables for males**

This table shows a clear value of descriptive statistics of different variables for male subjects measured during this study.

| Variables | N | Minimum | Maximum | Mean ± SD | SEM |
|---|---|---|---|---|---|
| Age (years) | 51 | 27.00 | 75.00 | 45.49±11.56 | 1.62 |
| Height (m) | 51 | 1.57 | 2.16 | 1.73±0.10 | 0.01 |
| Weight (kg) | 51 | 53.00 | 84.00 | 66.06±8.00 | 1.12 |
| Body mass index ($kg/m^2$) | 51 | 13.92 | 28.05 | 22.09±2.81 | 0.39 |
| Body surface area ($m^2$) | 51 | 0.02 | 0.20 | 0.02±0.03 | 0.00 |
| Medial canthal distance (cm) | 51 | 1.02 | 1.70 | 1.35±0.13 | 0.02 |
| Lateral intercanthal distance (cm) | 51 | 3.08 | 4.61 | 3.85±0.35 | 0.05 |
| Glabella hair line distance (cm) | 51 | 1.81 | 2.90 | 2.30±0.26 | 0.04 |

Table 6 developed by the authors

Results in table 6 indicated that the mean ± SD of age, height, weight, body mass index, body surface area, medial canthal distance, lateral inter canthal distance and glabella hair line distance were 45.49±11.56, 1.73±0.10, 66.06±8.00, 22.09±2.81, 0.02±0.03, 1.35±0.13, 3.85±0.35 and 2.30±0.26 respectively.

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

**Figure 7: Using Corex X3 Adobe software to measure and analyse the facial variables of lateral and medial intercanthal distances, and glabella hair line distance, respectively, to ensure accuracy of result**

Figure 7 was developed by the authors

**Table 8: Showing the descriptive statistics of the variables for females**

This table shows a clear value of descriptive statistics of different variables of female subjects measured during the course of this study.

| Variables | N | Minimum | Maximum | Mean ± SD | SEM |
|---|---|---|---|---|---|
| Age (years) | 29 | 32.00 | 58.00 | 41.28±5.52 | 1.03 |
| Height (m) | 29 | 1.34 | 1.90 | 1.734±0.11 | 0.02 |
| Weight (kg) | 29 | 51.00 | 81.00 | 67.14±8.01 | 1.49 |
| Body mass index (kg/m$^2$) | 29 | 17.96 | 35.65 | 22.16±3.66 | 0.68 |
| Body surface area (m$^2$) | 29 | .015 | .058 | 0.02±0.01 | 0.00 |
| Medial canthal distance (cm) | 29 | 1.05 | 1.69 | 1.40±0.14 | 0.03 |
| Lateral intercanthal distance (cm) | 29 | 3.30 | 4.80 | 3.96±0.31 | 0.06 |
| Glabella hair line distance (cm) | 29 | 1.91 | 2.63 | 2.29±0.19 | 0.03 |

Table 8 was developed by the authors

The results in Table 7 show that the mean ± SD of age, height, weight, body mass index, body surface area, medial canthal distance, lateral intercanthal distance, and glabella hair line distance were 41.28±5.52, 1.734±0.11, 67.14±8.01, 22.16±3.66, 0.02±0.01, 1.40±0.14, 3.96±0.31 and 2.29±0.1 9, respectively.

**Table 9: Showing the correlation between the height, weight, BMI, BSA and age with Medial canthal distance, Lateral intercanthal distance and Glabella hairline distance for males**

This table is concerned with the comparative correlation between some groups of variables stated in Table 3 above; it shows the degree of p-values with respect to the total number of male subjects used for this study.

| | | Height (m) | Weight (kg) | BMI (kg/m$^2$) | BSA (m$^2$) | Age (yrs) |
|---|---|---|---|---|---|---|
| Medial canthal distance (cm) | Pearson Correlation | 0.04 | 0.01 | -0.06 | -0.08 | 0.05 |
| | p-value | 0.78 | 0.92 | 0.69 | 0.58 | 0.73 |
| | N | 51 | 51 | 51 | 51 | 51 |
| Lateral intercanthal distance (cm) | Pearson Correlation | -0.16 | -0.06 | -0.05 | -0.11 | 0.04 |
| | p-value | 0.26 | 0.67 | 0.73 | 0.43 | 0.76 |
| | N | 51 | 51 | 51 | 51 | 51 |
| Glabella hairline distance (cm) | Pearson Correlation | 0.03 | -0.08 | -0.13 | -0.24 | -0.09 |
| | p-value | 0.83 | 0.57 | 0.38 | 0.08 | 0.52 |
| | N | 51 | 51 | 51 | 51 | 51 |

Table 9, developed by the authors

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Vol: 63 | Issue: 02 | 2026

In males, height, weight, and age indicated a positive correlation with medial canthal distance, which is not significant. Also, BMI and BSA showed a negative correlation with medial canthal distance, which is not significant. Lateral intercanthal distance showed a positive but not significant correlation with height, weight, BMI and BSA. On the other hand, age indicated a negative correlation with lateral intercanthal distance, which is not significant. Glabella hairline distance has a negative correlation that is not significant with weight, age, BMI and BSA. It also has a positive correlation with height, which is not significant.

**Table 10: Showing the correlation between the height, weight, BMI, BSA and age with Medial canthal distance, Lateral intercanthal distance and Glabella hairline distance for females**

This table is concerned with the comparative correlation between some groups of variables stated in Table 3 above; it shows the degree of p-values with respect to the total number of female subjects used for this study.

| | | Height (m) | Weight (kg) | BMI (kg/m$^2$) | BSA (m$^2$) | Age (yrs) |
|---|---|---|---|---|---|---|
| Medial canthal distance (cm) | Pearson Correlation | 0.34 | 0.01 | -0.34 | -0.23 | 0.69 |
| | p-value | 0.07 | 0.96 | 0.07 | 0.24 | 0.00 |
| | N | 29 | 29 | 29 | 29 | 29 |
| Lateral intercanthal distance (cm) | Pearson Correlation | 0.37 | 0.32 | -0.11 | 0.11 | 0.27 |
| | p-value | 0.04 | 0.09 | 0.59 | 0.58 | 0.15 |
| | N | 29 | 29 | 29 | 29 | 29 |
| Glabella hairline distance (cm) | Pearson Correlation | 0.00 | 0.02 | -0.07 | -0.03 | 0.28 |
| | p-value | 0.99 | 0.93 | 0.71 | 0.88 | 0.14 |
| | N | 29 | 29 | 29 | 29 | 29 |

Table 10, developed by the authors

In females, height and weight indicated a positive correlation with medial canthal distance, which is not significant. Also, BMI and BSA showed a negative correlation with medial canthal distance, which is not significant. As against what was observed in males, age correlated positively and significantly with medial canthal distance. Lateral intercanthal distance showed a positive correlation that is significant with height, but showed a positive correlation that is not significant with weight, BSA and age. It also showed a negative correlation with BMI, which is not significant. Glabella hairline distance has a negative correlation that is not significant with BMI and BSA. It also has positive correlation with height weight and age that is not significant.

**Table 11: Correlation of male forehead horizontal and vertical wrinkle with anthropometric variables**

This table shows the correlation between the male wrinkles' patterns discovered during this study with their measured anthropometric variables.

| | | Height (m) | Weight (kg) | Body mass index (kg/m$^2$) | Body surface area (m$^2$) | Medial canthal distance (cm) | Lateral intercanthal distance (cm) | Glabella hairline distance (cm) | Age (yrs) |
|---|---|---|---|---|---|---|---|---|---|
| **VW** | **Pearson Correlation** | -0.07 | 0.08 | 0.18 | -0.20 | -0.32 | -0.14 | -0.16 | -0.03 |
| | **p-value** | 0.64 | 0.59 | 0.20 | 0.159 | 0.02 | 0.32 | 0.27 | 0.82 |
| | **N** | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 |
| **HW** | **Pearson Correlation** | 0.21 | -0.06 | -0.27 | -0.13 | -0.09 | -0.23 | 0.00 | -0.07 |
| | **p-value** | 0.15 | 0.70 | 0.06 | 0.35 | 0.54 | 0.10 | 0.98 | 0.60 |
| | **N** | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 |

Table 11 was developed by the authors

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

In males, HW had no significant correlation with all the sampled anthropometric variables. Though height and glabella hairline distance showed positive correlation with the HW, weight, body mass index, body surface area, medial lateral intercanthal distance and age negatively correlated with HW. VW in males, as shown in the result of Table 10, correlated significantly and negatively with medial intercanthal distance. While the correlation with height, body surface area, medial-lateral intercanthal distance, glabella hairline distance and age were negative, that of the weight and body mass index was positive.

**Table 12: Correlation of female forehead horizontal and glabella vertical wrinkle with anthropometric variable**

This table shows the correlation between the female wrinkles' patterns discovered during this study and their measured anthropometric variables.

| | | Height (m) | Weight (kg) | Body mass index (kg/m2) | Body surface area (m2) | Medial canthal distance (cm) | Lateral intercanthal distance (cm) | Glabella hairline distance (cm) | Age (yrs) |
|---|---|---|---|---|---|---|---|---|---|
| **VW** | **Pearson Correlation** | -0.00 | -0.16 | -0.16 | 0.04 | -0.24 | -0.32 | -0.26 | -0.55 |
| | **p-value** | 0.99 | 0.42 | 0.40 | 0.83 | 0.21 | 0.10 | 0.17 | 0.002 |
| | **N** | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |
| **HW** | **Pearson Correlation** | 0.10 | -0.44 | -0.45 | -0.27 | 0.03 | -0.17 | 0.17 | -0.13 |
| | **p-value** | 0.61 | 0.02 | 0.02 | 0.16 | 0.88 | 0.38 | 0.37 | 0.50 |
| | **N** | 29 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |

Table 12 was developed by the authors

In the results of Table 11, female VW correlated negatively but not significantly with height, weight, body mass index, medial and lateral canthal distance, and glabella hairline distance. It also correlated positively but not significantly with body surface area, but showed a negative correlation that is significant with age. HW correlated negatively and significantly with weight and body mass index. It also correlated positively and not significantly with height, medial canthal distance, and Glabella hairline distance, but negatively and not significantly with body surface area, lateral canthal distance, and age.

## 4. DISCUSSION

Several factors can affect the facial wrinkle pattern of an individual; examples of such factors include race, age, gender, occupation, behaviour, etc. This study revealed, as shown in Figures 3 and 4, that the forehead facial wrinkle pattern of adult Yorubas of Southwest Nigeria is classified into two categories. The discovered Vertical and Horizontal patterns are in conformity with the work of Nilforoushzadeh et al. (2022) and Döhler et al. (2020), who opined that the forehead horizontal wrinkle and the Glabella vertical wrinkles are the two common forehead wrinkles. As shown in Table 1, there are eight varieties of the Horizontal pattern, and the Male gender has more of this pattern of wrinkles. This could be as a result of much exposure of the male subjects to sunlight; this is because the nature of their occupation leaves them with long-term exposure to sunlight. This pattern of forehead wrinkling is less common in female subjects than in males because they are less exposed to sunlight. This study conforms with (2019) and Shanbhag et al. (2019), who stated that overexposure to sunlight, which leads to dehydration, can cause facial wrinkling. The Few Broken Lines with Few Curves (FBLFC) that is most common horizontal wrinkle in females as seen in table 2 could be associated with postmenopausal hormonal imbalance in female gender, because all female used in this study with this pattern of facial wrinkles are within the age range of 45 -60years; this is in line

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

with Cannarozzo *et al*., (2021), Dimitriu *et al*., (2019), and Flood *et al*., (2019), which reported that intrinsic factors can contribute to development of facial wrinkle.

The number of horizontal wrinkles from this research correlated significantly with body mass index and had no correlation with height, weight, body surface area, medial, lateral intercanthal distances and glabella hairline distance. There were no correlations with weight, body surface area, medial and lateral intercanthal distances and age with respect to the number of curves. Glabella hair line distance has no significant correlation with weight, age, body mass index and body surface area, as seen in Table 5. The negative correlation of glabella hair line distance with height in this research indicated that the surface area of an individual is directly proportional to the individual's horizontal forehead wrinkles. This, as opined by Chiquet (2022), states that the more the body surface area of an organism, the more it is exposed to the environment.

The negative correlation of body surface area with horizontal facial wrinkle and body weight in this research agrees with (Lephart & Naftolin, 2021), (Miller *et al.,* 2019), which opined that subcutaneous fat rigidity in early postmenopausal women causes wrinkles and increases their body wrinkles. This might be the reason why we observed in this research that female subjects within the menopause age are the ones with significant weight and prominent forehead facial wrinkles. The medial and lateral intercanthal distances, as shown in Table 9, were negatively correlated with height, weight, BMI, BSA, and age, which clearly indicated that as these variables decreased, the horizontal forehead wrinkle increased. In males, horizontal wrinkles have no significant correlations with some of the sampled anthropometric variables. The height and glabella hairline distance showed a positive correlation with the horizontal wrinkles, which might be because of the male sex link, because this association is absent in the female gender.

However, the reason for the above observation is unclear.

The height and glabella hairline distance that were positively correlated with the horizontal wrinkle might be a result of age, as seen in Table 9, which shows that when the individuals' age increases, loss of hair that increases glabella hairline distance increases too, thereby leading to more direct exposure of the skin to sunlight, which might lead to sagging of the skin (Boahene *et al*., 2022; Berry, 2021; Diepenbrock *et al*., 2021). Glabella vertical wrinkle was discovered to be of five (5) kinds as stated in 3.2 above. Glabella vertical wrinkle is not as common as the Horizontal wrinkles among the people of Southwest Nigeria. This could be as a result of age and habit, because individuals found prominently with this type of wrinkle are in their late 50s. The habit of squinting, as shown in Figures 4 & 5 of this study, is in line with the position of Lee et al. (2021), Flament et al. (2019), and Cao et al. (2020), who stated that habit and age are major factors that can cause facial wrinkles. Centre pit wrinkle (CPW) that has the lowest frequency of the glabella vertical wrinkle in this study could be because of genetic makeup and sex-linked, because we discovered that the few subjects that has this kind of wrinkle pattern were all male that shared other factors such as food, occupation, habits and age with some other female subjects that do not have it.

According to this study, the 22 (27.5%) of subject that do not have glabella vertical wrinkles could be as a result of age, because those that does not show any sign of this wrinkle were young people bellow 24 years of age, which makes this study to be in line with (Ganel & Goodale, 2021), which stated that facial wrinkles can only be seen on adults and in disagreement with Alghonaim *et al*., (2022) which stated that 25years of age mark the onset of forehead facial wrinkles. In this study, the females do not have CPW and CDW because the frequency for each one of them is 0, which accounted for 0% of the subjects, as shown in Table 2. This could be because of sex-linked genetic makeup, because men who have this kind of facial wrinkle shared other factors with females who do not have it. The few shallow wrinkle (FSW) and few deep wrinkle (FDW) in this study seen as the most frequent, could be

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

as a result of occupation and sun light because all the subjects with few shallow vertical wrinkles are those that work in the office while all those with few deep vertical wrinkles are those involved in some occupation of carrying load on the head with exposure to sun light for long period of time. Therefore, this research is in agreement with (Kim *et al*., 2018), which stated that overexposure to sunlight could lead to dehydration, which might cause facial wrinkling. In Table 3 of this study, females did not have as many vertical wrinkles as men. This might be because of their diets and occupation, as all the female subjects without this type of wrinkle admitted to eating more fatty foods and are of greater body weight than those who have this type of wrinkle. The negative correlation observed in female glabella vertical wrinkles with height, weight, body mass index, medial and lateral canthal distance, with glabella hairline distance, as shown in Table 10, could be because of genetic makeup, because women always have lighter and smaller bones and muscle structure when compared to men.

## 5. CONCLUSION

This study presents the first comprehensive analysis of forehead wrinkle patterns among Yoruba adults in Southwest Nigeria, establishing a novel biometric identification system for sub-Saharan African populations. The research identified eight distinct horizontal wrinkle patterns and five vertical wrinkle patterns, with Few Broken Lines with Few Curves (FBLFC) being predominant in males (31.4%) and Many Broken Lines with Few Curves (MBLFC) in females (37.9%). The dominant vertical patterns were Few Shallow Wrinkles (FSW) in males (29.4%) and Few Deep Wrinkles (FDW) in females (29.4%).

### Academic Contribution and Innovation

This research makes significant academic contributions to forensic anthropology and biometric science by: (1) establishing the first documented forehead wrinkle classification system for West African populations, filling a critical gap in regional forensic databases; (2) demonstrating gender-specific wrinkle patterns that can enhance individual identification accuracy in criminal investigations; (3) providing baseline anthropometric correlations between facial measurements and wrinkle formations in tropical climates; and (4) introducing a standardized photographic protocol using Nikon D-60 camera specifications for consistent wrinkle documentation in field conditions. Unlike existing literature that predominantly focuses on Caucasian and East Asian populations, this study uniquely characterises wrinkle morphology in darker skin tones, where UV protection mechanisms create distinct ageing patterns.

### Recommendations and Future Directions

Future research should expand the sample size to include other Nigerian ethnic groups (Hausa, Igbo) to develop a comprehensive national wrinkle database. Longitudinal studies tracking wrinkle development over 5-10-year periods are recommended to understand temporal changes and improve age estimation accuracy. Integration of artificial intelligence and machine learning algorithms should be explored to automate wrinkle pattern recognition for real-time forensic applications. Additionally, investigation of environmental factors such as humidity, temperature, and occupational exposure specific to West African climates could refine the predictive models.

### Research Perspective

This foundational work opens new avenues for developing region-specific biometric identification systems across Africa. The methodology established here can be adapted for other facial landmarks and extended to include scarification patterns, tribal marks, and other culturally relevant identification features. Future studies should also investigate the genetic basis of wrinkle formation patterns and their inheritance patterns within Nigerian family lineages. The integration of this wrinkle

DOI: 10.5281/zenodo.18466807
Vol: 63 | Issue: 02 | 2026

database with existing fingerprint and DNA databases could significantly enhance criminal identification capabilities in Nigeria and similar tropical regions.

The clinical applications in aesthetic medicine and dermatology also warrant further exploration, particularly in developing culturally appropriate anti-ageing treatments and surgical planning for African populations. This research provides the essential baseline data for evidence-based cosmetic interventions tailored to West African facial anatomy and ageing patterns.

**Authors' Contributions**

**Chukwu CB:** Study conception and design, data collection and fieldwork, statistical analysis, manuscript drafting, revision coordination. **Enye LA:** Statistical analysis supervision, manuscript editing, and data interpretation. **Saka OS:** Forensic anthropology expertise, methodology editing, data interpretation. **Oniyide AA:** Manuscript proofreading, data interpretation, and ethical compliance oversight. **Fafure AA:** Manuscript proofreading, statistical validation, data analysis quality control. **Edem EE:** Technical manuscript editing, data analysis verification. **Ogugua EO:** Research supervision, study design, data interpretation oversight, and final manuscript approval.

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**Institutional Review Board Statement**

This study adhered to the Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects, adopted by the 18th WMA General Assembly, Finland, June 1964, and amended by the 64th WMA General Assembly, Fortaleza, Brazil, October 2013. The study was approved by the local Research and Ethics Committee of College of Medicine and Health Sciences, Afe Babalola University, with ethical numbers ABUADHREC/12/06/2022/66. Volunteers gave their informed consent to participate in the study.

**Conflict of Interest**

The authors have no conflict of interest to declare

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