

# Normal corneal endothelial cell density in Nigerians

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**Aim:** The aim of the study was to describe the corneal endothelial cell density of adults at the MeCure Eye Center and to determine the relationship between age, sex, and corneal endothelial cell density.

**Methods:** This study was a retrospective study looking at those records of individuals who had undergone specular microscopy or corneal endothelial cell count measurement at the MeCure Eye Center.

**Results:** The endothelial cell characteristics of 359 healthy eyes of 201 volunteers were studied. The mean corneal endothelial cell density (MCD) was  $2,610.26 \pm 371.87$  cells/mm<sup>2</sup> (range, 1,484–3,571 cells/mm<sup>2</sup>). The MCD decreased from 2,860.70 cells/mm<sup>2</sup> in the 20–30-year age group to 2,493.06 cells/mm<sup>2</sup> in the >70-year age group, and there was a statistically significant relationship between age and MCD with a *P*-value of <0.001. There was no statistically significant correlation between sex and corneal endothelial cell density (*P*=0.45).

**Conclusion:** This study shows that endothelial cell density in Nigerian eyes is less than that reported in the Japanese, American, and Chinese eyes, and is comparable to that seen in Indian and Malaysian eyes.

**Keywords:** corneal, endothelial cell density, Nigerian

## Introduction

The corneal endothelial cell density is essential in the clinical assessment of the cornea to determine its function and ability to respond to stress. It is important to determine a reference range for different population groups in order to establish abnormal values and aid predictability, especially with the noted increase in intraocular surgeries. The cornea is the transparent, clear tissue at the front and center of the eye, and it helps to maintain the transparency at the front of the eye, which enables a clear pathway for images to be viewed. The average corneal diameter is 11.5 mm vertically and 12 mm horizontally.<sup>1</sup>

The cornea consists of the following layers: the epithelium, the Bowman layer, the stroma, the Descemet's membrane, and the endothelium. The cornea endothelium is a very important factor in the optical transparency of the cornea, and this transparency is maintained by its ability to pump water out of the corneal stroma against an osmotic gradient; it also maintains corneal hydration.<sup>2,3</sup> The cornea endothelium is metabolically active and utilizes the Na<sup>+</sup>-K<sup>+</sup> pump for keeping the stroma at its usual hydrated state of 70% water to prevent stromal edema.<sup>4</sup> The average normal mean corneal endothelial cell density (MCD) is usually the highest at birth (~3,000 cells/mm<sup>2</sup>), and it declines slowly; a minimal density of 400–500 cells/mm<sup>2</sup> is required to sustain the pumping activity of the endothelium, and values below this have been associated with bullous keratopathy.<sup>5</sup>

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Nowadays, various specular microscopic techniques and machines have made the evaluation of the endothelial density possible.

Damage to the human corneal endothelium consists of a healing process that includes a combination of cell enlargement and cell spread, and these processes create a layer of cells on the inner surface of the cornea.<sup>6</sup> The corneal endothelial wound repair is also reflected as an increase in the variation of individual cell areas, which is also described as the coefficient of variation (CV). Six-sided or hexagonal cells usually give an indication that there is an evenly distributed membrane surface tension, which can be equalized to normal cells and in the normal cornea; the percentage of the hexagonal cells is expected to be 60%, which is decreased by stress.<sup>7</sup> The less healthy the endothelium, the lower the endothelial cell count and the greater variation in cell size and shape.<sup>8</sup>

Corneal endothelial imaging can be contact or noncontact imaging. Noncontact endothelial imaging has the advantage of reducing the risk of corneal epithelial damage and artifacts during imaging.<sup>7,9</sup>

Several studies have been carried out looking at corneal endothelial morphology in Turkish, Iranian, Filipino, American, Japanese, and different populations.<sup>9–12</sup> This study gives additional data attributable to the Nigerian population that have not been published in the literature as far as the authors are aware of.

The specific objectives of this study were to describe the corneal endothelial cell density of adults at the McCure Eye Center (Lagos, Nigeria) and to determine the relationship between age, sex, and corneal endothelial cell density.

## Materials and methods

Ethical approval was obtained from the Ethical Committee of the Teaching Hospital of the University of Port Harcourt. Patient consent was not required as this was a retrospective study and all patient data was de-identified; however, approval was obtained from the McCure Healthcare Limited Chief Operations Officer to retrieve the necessary patient data.

## Study design

This study was a retrospective study looking at the records of individuals who had undergone specular microscopy or corneal endothelial cell count measurement at the McCure Eye Center. The machine used was a Konan Medical Non-Con Robo Specular Microscope X, Model No NSP-9900 (Konan Medical Inc., Nishinomiya, Japan), which was a noncontact specular microscope.

## Inclusion criteria

The inclusion criteria were as follows: adults 20 years of age and above who were walk-in patients or volunteers from staff or relatives of patients; and adults who were born in Nigeria and/or had spent a minimum of 15 years in Nigeria.<sup>13</sup>

## Exclusion criteria

The exclusion criteria were as follows: individuals younger than 20 years; non-Nigerian individuals; individuals with a previous history of ocular trauma; individuals with a past history of ocular surface disease; and individuals with a past history of ocular surgery or a past history of endothelial dysfunction.

## Data collection

Information such as age, sex, eye measured, average cell density, standard deviation, average cell area, percentage of hexagonal cells, CV, maximum cell area, and minimum cell area as measured by the machine was retrieved and analyzed.

## Data analysis

Data analysis was performed using SPSS software (Version 10.0; SPSS Inc., Chicago, IL, USA). The paired and unpaired *t*-tests and Pearson correlation analysis were also used. Analysis of variance and linear regression analysis were used to examine the change in endothelial cell characteristics with age. *P*-values <0.05 were determined as statistically significant.

## Results

The endothelial cell characteristics of 359 healthy eyes of 201 volunteers were studied. There were 207 males and 152 females. The mean age of the population was 50.35±20.13 years (range, 20–93 years). The MCD was 2,610.26±371.87 cells/mm<sup>2</sup> (range, 1,484–3,571 cells/mm<sup>2</sup>). The mean cell area was 392.22±68.03 μm<sup>2</sup> (range, 280–674 μm<sup>2</sup>). The CV in the cell size was 43.95%±9.50% (range, 25%–96%), and the percentage of hexagonal cells was 46.52%±8.83% (range, 18%–78%).

The MCD decreased from 2,860.70 cells/mm<sup>2</sup> in the 20–30-year age group to 2,493.06 cells/mm<sup>2</sup> in the >70-year age group (Table 1), and there was a statistically significant relationship between age and MCD with a *P*-value of <0.001.

The average corneal endothelial cell density was seen to be higher in females than in males, but it should also be noted that there were more males in this study than females. There was no statistically significant correlation between sex and corneal endothelial cell density (*P*=0.45; Table 2).

There were significant correlations between age and MCD (*r*=−0.318, *P*<0.001; Figure 1).

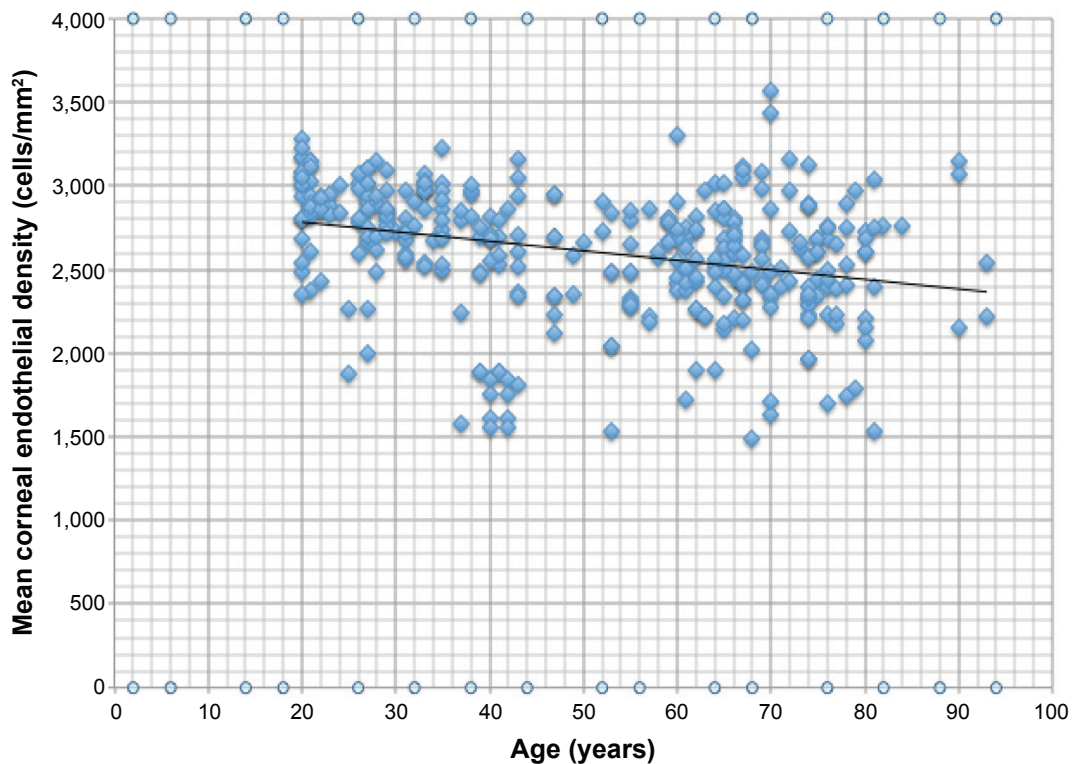
**Table 1** Characteristics of the endothelial cells in different age groups of the study population

Age (years)	Patients (n)	Mean corneal endothelial cell density (cells/mm <sup>2</sup> ; mean ± SD)	Hexagonality (%; mean ± SD)	CV in cell size (%; mean ± SD)	Mean cell area (μm <sup>2</sup> ; mean ± SD)
20–30	81	2,860.70±227.06	50.83±7.26	41.44±7.31	351.25±31.00
31–40	62	2,631.26±394.70	43.40±8.68	45.47±9.86	391.42±77.95
41–50	31	2,433.74±442.42	43.00±10.32	48.16±11.73	426.23±88.71
51–60	37	2,545.03±319.73	45.38±9.21	42.38±7.73	400.00±60.02
61–70	81	2,538.04±362.48	46.40±8.15	43.70±10.88	403.04±66.19
>70	67	2,493.06±353.35	46.63±8.68	44.79±8.72	409.79±66.71
Total	359	2,610.26±371.87	46.52±8.83	43.95±9.50	392.22±68.03

**Abbreviation:** CV, coefficient of variation.

**Table 2** Average corneal endothelial cell density in males and females

Age group (years)	Male cell density (cells/mm <sup>2</sup> ; mean ± SD)	Female cell density (cells/mm <sup>2</sup> ; mean ± SD)
20–30	2,859.12±225.77	2,861.79±230.33
31–40	2,637.09±350.42	2,624.18±449.21
41–50	2,409.57±421.38	2,503.25±522.85
51–60	2,629.00±275.31	2,318.30±334.17
61–70	2,562.14±389.12	2,497.07±314.08
>70	2,477.00±403.985	2,515.43±273.17
Total	2,597.52±375.94	2,627.61±366.77



**Figure 1** Scatter plots show correlation between age and the mean corneal endothelial cell density.

Table 3 Comparison of mean corneal endothelial cell density in different population groups

Age group (years)	American <sup>12</sup>		Japanese <sup>12</sup>		Indian <sup>14</sup>		Chinese <sup>15</sup>		Malay <sup>16</sup>		Nigerian	
	No of eyes	Cell density (cell/m <sup>2</sup> ; mean $\pm$ SD)	No of eyes	Cell density (cell/m <sup>2</sup> ; mean $\pm$ SD)	No of eyes	Cell density (cell/m <sup>2</sup> ; mean $\pm$ SD)	No of eyes	Cell density (cell/m <sup>2</sup> ; mean $\pm$ SD)	No of eyes	Cell density (cell/m <sup>2</sup> ; mean $\pm$ SD)	No of eyes	Cell density (cell/m <sup>2</sup> ; mean $\pm$ SD)
20–30	11	2,977 $\pm$ 324	18	3,893 $\pm$ 259	104	2,782 $\pm$ 250	100	2,988 $\pm$ 243	49	2,783 $\pm$ 286	81	2,860.70 $\pm$ 227.06
31–40	6	2,739 $\pm$ 208	10	3,688 $\pm$ 245	96	2,634 $\pm$ 288	100	2,920 $\pm$ 325	9	2,551 $\pm$ 319	62	2,631.26 $\pm$ 394.70
41–50	11	2,619 $\pm$ 321	10	3,749 $\pm$ 407	97	2,408 $\pm$ 274	97	2,935 $\pm$ 285	10	2,744 $\pm$ 239	31	2,433.74 $\pm$ 442.42
51–60	13	2,625 $\pm$ 172	10	3,386 $\pm$ 455	98	2,438 $\pm$ 309	97	2,810 $\pm$ 321	15	2,509 $\pm$ 228	37	2,545.03 $\pm$ 319.73
61–70	8	2,684 $\pm$ 384	6	3,307 $\pm$ 330	88	2,431 $\pm$ 357	90	2,739 $\pm$ 316	25	2,560 $\pm$ 304	81	2,538.04 $\pm$ 362.48
>70	15	2,431 $\pm$ 339	5	3,289 $\pm$ 313	54	2,360 $\pm$ 357	83	2,778 $\pm$ 365	17	2,570 $\pm$ 301	67	2,493.06 $\pm$ 353.35

## Discussion

Corneal endothelial cell analysis is important toward predicting the viability of the cornea especially after intraocular procedures like cataract surgery. Different studies have shown significant differences in corneal endothelial properties among races and ethnic groups.<sup>10–12,14,16,17</sup> The MCD obtained in this study (2,610.26 $\pm$ 371.87 cells/mm<sup>2</sup>) revealed results similar to values obtained in Indian eyes (Table 3).<sup>14</sup> These values are low compared to the results obtained from the Japanese eyes (Table 3).<sup>12</sup>

There is also a similar trend of decrease in MCD with advancing age as seen in various other studies.<sup>12,14,15</sup> There was no significant relationship between MCD and sex even though females in the study had higher values than the males (Table 2). It is not immediately clear the reason for the disparity; similarly, in Filipinos, females are reported to have higher MCD than males and a slight increase with age up to 40 years before a slight decline with age in both sexes.<sup>11</sup>

Regression analysis done showed significant correlations between age and MCD ( $r=-0.318$ ,  $P<0.001$ ; Figure 1). The results of this study have also shown that with increasing age, there is also a general trend toward a decline in MCD, hexagonality, variation in cell size (CV), and mean cell area (Table 1). These findings are in agreement with many previous studies.<sup>10,11,14,18</sup> This study confirms the previous report that MCD correlates with age and that endothelial cell count decreases with increasing age.<sup>17</sup>

It had been hypothesized that the differences in MCD between different populations might be as a direct result of variations in corneal diameter and endothelial surface area, but it is difficult for this relationship to be ascertained in this study as corneal diameter was not measured.<sup>14</sup>

## Conclusion

In conclusion, this study reports normative endothelial characteristics in a Nigerian population that may serve as a useful baseline for future studies. This study has reported a decrease in MCD with age. There was no statistically significant difference in MCD between sexes. Comparison with previous studies indicates that endothelial cell density in the Nigerian eyes is less than that reported in the Japanese, American, and Chinese eyes, and is comparable to Indian and Malaysian eyes.

## Disclosure

The authors report no conflicts of interest in this work.

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