

## **Assessment of Intraocular Pressure, Central Corneal Thickness and Corneal Diameter in Patients with Downs Syndrome**

### **ABSTRACT**

This research was designed as a case-control study for the assessment of intraocular pressure (IOP), central corneal thickness (CCT) and corneal diameter (CD) in Down syndrome persons. The intraocular pressure, central cornea thickness and cornea diameter of 46 Down syndrome persons (26 males and 20 females) and 46 persons in a control group (22 males and 24 females) from a similar ethnic background were enrolled in the study. Intraocular pressure, Central corneal thickness and Corneal diameter were measured using puff air tonometer, ultrasound pachymeter and Keratometer respectively. The mean age of the persons with Down syndrome was  $24.26 \pm 4.449$  (male =  $24.08 \pm 4.489$  and female =  $24.50 \pm 4.501$ ) and the mean age of control subjects was  $24.91 \pm 4.671$  (male =  $24.95 \pm 4.726$  and female =  $24.88 \pm 4.721$ ). The mean values for IOP, CCT and CD in Down syndrome persons was  $13.83 \pm 3.735$ ,  $478.34 \pm 23.268$ ,  $10.4128 \pm 0.62120$  while the mean value for IOP, CCT and CD in control subjects was  $14.50 \pm 3.358$ ,  $545.74 \pm 17.343$ ,  $11.7043 \pm 0.10532$  respectively. From SPSS version 23 data output, data analysis using the Independent Sample T test at 0.05 level of significance and 95% confidence interval revealed for IOP a P value of 0.567. Since  $P (0.567) > 0.05$ , the Intraocular Pressure (IOP) of people with Down Syndrome and a control group are the same. For CCT it revealed a P value of 0.001. Since  $P (0.001) < 0.05$ , the Central Corneal Thickness (CCT) of people with Down Syndrome and a control group are not the same. For CD it revealed a P value of 0.001. Since  $P (0.000) < 0.05$ , the Corneal Diameter (CD) of people with Down Syndrome

and a control group are not the same. In conclusion, the results of the study showed that individuals living with Down Syndrome had decreased Central Corneal Thickness and Corneal Diameter but the Intraocular Pressure was the same, when compared with normal individuals. It is therefore recommended that the Eye Doctors should note this while examining patients with Down Syndrome.

Key word: medical treatment, Corneal Thickness, Intraocular Pressure, Down syndrome

## INTROD UCTION

“Down syndrome or Down's syndrome, also known as Trisomy 21, is a genetic disorder caused by the presence of all or part of a third copy of chromosome 21” (*Patterson, 2009*). “It is usually associated with physical growth delays, mild to moderate intellectual disability and characteristic facial features” (*Weijerman et al, 2010*). “The average IQ of a young adult with Down syndrome is 50, equivalent to the mental ability of an 8- or 9-year-old child, but this can vary widely” (*Malt, 2013*). There is no cure for Down syndrome (*Steinbock and Bonnie, 2017*). “Education and proper care have been shown to improve quality of life” (*Evans-Martin and Fay, 2009*).

“Recent advancement in medical treatment with social support has increased the life expectancy for DS population. In developed countries, the average life span for DS population is 55 years” (*Glasson et al, 2002*).

## **MATERIALS AND METHODS**

### **Area of Study**

This study was carried out in Perofak eye clinic, Owerri, Imo State. The subjects involved include male and female persons diagnosed of Down Syndrome at servants of charity congregation Umuguma and servants of charity congregation Don Guanella centre Nnebukwu Oguta.

### **Research Design**

This study was designed to be a case control clinical study which is aimed at accessing and comparing the Intraocular pressure, cornea thickness and cornea diameter of Down syndrome persons with that of the normal persons.

### **Population of Study**

#### **Inclusion Criteria**

All Down Syndrome persons in the centre without history of ocular trauma/pathology.

#### **Exclusion Criteria**

Down syndrome persons in the centre with history of ocular trauma and vision threatening pathologies.

### **Sample Size Determination**

The total number of Down syndrome persons were 46 and they were all inclusive in the research.

### **Instruments for Data Collection**

- i. Snellen's visual acuity chart (literate and animal chart): for distance visual acuity measurement.
- ii. Snellen's near chart: for near visual acuity measurement.
- i. Pen torch: for external eye examination.
- i. Heine Ophthalmoscope: for internal eye examination.
- ii. Non contact Tonometer: for Intraocular pressure measurement.
- iii. Pachymeter: for cornea thickness measurement.
- iv. keratometer: for cornea diameter measurement.

### **Validation of Instruments**

The instruments used for this study were standard instruments approved by the Optometry and Dispensing Opticianry Registration Board of Nigeria (ODORBN) and validated by the department.

### **Procedure for Data Collection**

Proper demographic data of patients was taken including name, gender and age. Case history of patient was taken and cause of Down Syndrome was ascertained from guardian.

Visual acuity of patients was taken at far and near. External examination was performed using pen torch. Internal examination was performed to rule out pathologies using the Ophthalmoscope.

Measurement of Intraocular pressure was with the use of Puff Air Non Contact Tonometer. The subjects were made to sit upright while looking straight ahead. Patient cornea was viewed through the peephole and the air puffed automatically. The Intraocular Pressure reading was read off the tonometer screen.

Corneal thickness was measured by asking the subjects to sit on a stool or chair. Local anesthetic was instilled into the eye and the probe was rested on the corneal surface to detect cornea thickness.

Corneal diameter was taken by placing the subjects behind the Keratometer. They were asked to look straight into the peephole while the measurement of the Corneal diameter was taken from the screen.

### **Procedure for Data Analysis**

Frequencies and descriptive tables were generated using the Statistical Package for Social Sciences (SPSS). The Pearson Chi-square and the student t-test statistics was used to explore relationships and associations for nominal and quantitative variables as appropriate.  $AP < .05$  was considered statistically significant.

## RESULTS

A total of forty six (46) Down syndrome persons and forty six (46) persons in a control group were examined in this research work. The tables below show results from the SPSS data output.

**Table 1: Age distribution for Down syndrome persons**

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<b>Age</b>	<b>n</b>	<b>%</b>
15-19	7	15.22
20-23	9	19.57
24-27	19	41.30
28-32	11	23.91
Total	46	100

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**n**= number of subjects, **%**= percentage of subjects

The table above shows the age distribution of Down syndrome persons that were used in the research. Subjects between 24-27 (41.30%) years of age were higher in number than other subjects. The least number of subjects fall within 15-19 (15.22%).

**Table 2: Age distribution for Control group**

<b>Age</b>	<b>n</b>	<b>%</b>
15-19	9	19.57
20-23	6	13.04
24-27	15	32.61
28-32	16	34.78
Total	46	100

**n=** number of subjects, **%=** percentage of subjects

The table above shows the age distribution of Control subjects that were used in the research. Subjects between 28-32 (34.78%) years of age were higher in number than other subjects. The least number of subjects fall within 20-23 (13.04%).

**Table 3: Gender distribution of Down syndrome persons**

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<b>Gender</b>	<b>n</b>	<b>%</b>
Male	26	56.52
Female	20	43.48
Total	46	100

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**n**= number of subjects, %= percentage of subjects

The table above shows the gender distribution of Down syndrome persons used in the research. There were 26 (56.52%) male Down syndrome persons and 20 (43.48%) female Down syndrome persons. There were more male Down syndrome persons than female Down syndrome persons.

**Table 4: Gender distribution of control subjects**

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<b>Gender</b>	<b>n</b>	<b>%</b>
Male	22	47.83
Female	24	52.17
Total	46	100

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**n**= number of subjects, %= percentage of subjects

The table above shows the gender distribution of Control subjects used in the research. There were 22 (47.83%) male control subjects and 24 (52.17%) female control subjects. There were more female control subjects than male control subjects.

**Table 5: Age and gender distribution of Down syndrome persons**

Age group	Males		Females	
	n	%	n	%
15-19	5	19.23	2	10
20-23	4	15.38	5	25
24-27	11	42.31	8	40
28-32	6	23.08	5	25
Total	26	56.52	20	43.48

**n**= number of subjects, **%**= percentage of subjects

The table above shows the age and gender distribution of Down syndrome persons. Most male and female Down syndrome persons occurred between the ages of 24-27. The least numbers of females occurred within the age group of 15-19 (10%).

**Table 6: Age and gender distribution of control subjects**

Age group	Males		Females	
	n	%	n	%
15-19	5	22.73	4	16.67
20-23	2	9.09	4	16.67
24-27	6	27.27	9	37.50
28-32	9	40.91	7	29.16
Total	22	47.83	24	52.17

**n**= number of subjects, **%**= percentage of subjects

The table above shows the age and gender distribution of control subjects. Most male control subjects occurred between the ages of 28-32 (40.91%) and females 24-27 (37.50%). The least numbers occurred within the age group of 20-23 for the males (9.09%).

**Table 7: Descriptive statistics of age of Down syndrome persons**

	<b>n</b>	<b>Range</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>S.E.M</b>	<b>S.D</b>
Male	26	16	15	31	24.08	.880	4.489
Female	20	17	15	32	24.50	1.007	4.501
Total	46	17	15	32	24.26	.656	4.449

n= number of subjects, Min= minimum, Max= maximum, S.E.M standard error mean, S.D= standard deviation.

The table above shows descriptive statistics of age of Down syndrome persons used in the research. The mean age of females is higher with 24.50 (4.501) years while the males have mean age of 24.08 (4.489) years. As such, the females are older than the males.

**Table 8: Descriptive statistics of age of control group**

	<b>n</b>	<b>Range</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>S.E.M</b>	<b>S.D</b>
Male	22	15	17	32	24.95	1.007	4.726
Female	24	16	16	32	24.88	.964	4.721
Total	46	16	16	32	24.91	.689	4.671

n= number of subjects, Min= minimum, Max= maximum, S.E.M standard error mean, S.D= standard deviation.

The table above shows descriptive statistics of age of control group used in the research. The mean age of males is higher with 24.95 (4.726) years while the females have mean age of 24.88 (4.721) years. As such, the females are older than the males.

**Table 9: Descriptive statistics of age and IOP of Down syndrome and Control group.**

	<b>n</b>	<b>Range</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>S.E.M</b>	<b>S.D</b>
Control age	46	16	16	32	24.91	.689	4.671
DownS age	46	17	15	32	24.26	.656	4.449
Control IOP	46	10	10	20	14.50	.495	3.358
DownS IOP	42	12	9	21	13.83	.576	3.735

n= number of subjects, Min= minimum, Max= maximum, S.E.M standard error mean, S.D= standard deviation.

The table above shows descriptive statistics of age and IOP of Down syndrome and Control group. The mean Down syndrome age is 24.26 (4.449) years and mean Down syndrome IOP 13.83 (3.735) while the mean control age is 24.91 (4.671) years and mean control IOP 14.50 (3.358); as such the mean age of the control group is greater than that of the Down syndrome persons, also the mean IOP of the control group is greater than that of the Down syndrome persons.

**Table 10: Descriptive statistics of age and CCT of Down syndrome and Control group.**

	<b>n</b>	<b>Range</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>S.E.M</b>	<b>S.D</b>
Control age	46	16	16	32	24.91	.689	4.671
DownS age	46	17	15	32	24.26	.656	4.449
Control CCT	46	120	440	560	545.74	2.557	17.343
DownS CCT	38	79	441	520	478.34	3.775	23.268

n= number of subjects, Min= minimum, Max= maximum, S.E.M standard error mean, S.D= standard deviation.

The table above shows descriptive statistics of age and CCT of Down syndrome and Control group. The mean Down syndrome age is 24.26 (4.449) years and mean Down syndrome CCT 478.34 (23.268) while the mean control age is 24.91 (4.671) years and mean control CCT 545.74 (17.343); as such the mean age of the control group is greater than that of the Down syndrome persons, also the mean CCT of the control group is greater than that of the Down syndrome persons.

**Table 11: Descriptive statistics of age and CD of Down syndrome and Control group.**

	<b>n</b>	<b>Range</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>S.E.M</b>	<b>S.D</b>
Control age	46	16	16	32	24.91	.689	4.671
DownS age	46	17	15	32	24.26	.656	4.449
Control CD	46	.40	11.50	11.90	11.7043	.01553	.10532
DownS CD	39	1.80	9.10	10.90	10.4128	.09947	.62120

n= number of subjects, Min= minimum, Max= maximum, S.E.M standard error mean, S.D= standard deviation.

The table above shows descriptive statistics of age and CD of Down syndrome and Control group. The mean Down syndrome age is 24.26 (4.449) years and mean Down syndrome CD 10.4128 (.62120) while the mean control age is 24.91 (4.671) years and mean control CD 11.7043 (.10532); as such the mean age of the control group is greater than that of the Down syndrome persons, also the mean CD of the control group is greater than that of the Down syndrome persons.

## TESTING OF HYPOTHESES

### Testing the first hypothesis

$H_{O1}$ : The Intraocular Pressure (IOP) of people with Down Syndrome and a control group are the same.

**Table 12: SPSS data analysis result showing P value for testing of hypothesis**

Variable	P-value
IOP	0.567

From SPSS version 23 data output, data analysis using the Independent Sample T test at 0.05 level of significance and 95% confidence interval revealed a P value of 0.567. Since  $P (0.567) > 0.05$ , we accept the null hypothesis.

### Testing the second hypothesis

HO<sub>2</sub>: The Central Corneal Thickness (CCT) of people with Down Syndrome and a control group are the same.

**Table 13: SPSS data analysis result showing P value for testing of hypothesis**

Variable	P-value
CCT	0.001

From SPSS version 23 data output, data analysis using the Independent Sample T test at 0.05 level of significance and 95% confidence interval revealed a P value of 0.001. Since  $P (0.001) < 0.05$ , we reject the null hypothesis and accept the alternate.

HA<sub>2</sub>: The Central Corneal Thickness (CCT) of people with Down Syndrome and a control group are not the same.

### Testing the third hypothesis

HO<sub>3</sub>: The Central Diameter(CD) of people with Down Syndrome and a control group are the same.

**Table 14: SPSS data analysis result showing P value for testing of hypothesis**

Variable	P-value
CD	0.000

From SPSS version 23 data output, data analysis using the Independent Sample T test at 0.05 level of significance and 95% confidence interval revealed a P value of 0.001. Since  $P(0.000) < 0.05$ , we reject the null hypothesis and accept the alternate.

HA<sub>3</sub>: The Central Diameter (CD) of people with Down Syndrome and a control group are not the same.

## DISCUSSION

Evereklioglu *et al* (2002) investigated “the CCT in children with Down syndrome concluded that children with Down syndrome had a decreased CCT compared with healthy control subjects, which should be kept in mind for IOP measurements and when developing approaches for keratorefractive treatment of patients with Down syndrome”.

On the other hand, Khawaja *et al* (2013) evaluated “the CCT in individuals with ID they concluded that CCT should be kept in mind during measurements of IOP in individuals with ID because their CCTs may be greater than those in the general population and so children with ID, particularly those with syndromic ID, have an increased CCT compared with healthy control subjects because the difference in the IOP is not clinically significant, elevated IOPs in children with ID still need further investigation”.

Again, Tomoko *et al* (2006) in his research to “compare the prevalence of glaucoma in adults with DS to that in non-DS control adults; this result showed that the prevalence of glaucoma in adult patients with DS was significantly higher than that in age-matched control subjects”.

These contradictions and inconsistency in results may be attributed to DS person’s lack of co-operation during eye examinations.

This research provides valuable information on the assessment of intraocular pressure, central corneal thickness and corneal diameter in Down syndrome persons. This

research was designed as a case-control study. The intraocular pressure, central cornea thickness and cornea diameter of 46 Down syndrome persons (26 males and 20 females) and 46 persons in a control group (22 males and 24 females) from a similar ethnic background were enrolled in the study. Of the 46 DS persons, four (4) persons were not compliant during the IOP measurement; eight (8) persons were not compliant during the CCT measurement; six (6) people were not compliant during the CD measurement. Visual acuity could not be checked conventionally due to poor cooperation and response. Intraocular pressure, Central corneal thickness and Corneal diameter were measured by puff air tonometer, ultrasound pachymeter and Keratometer respectively.

The mean age of the persons with Down syndrome was 24.26 +/- 4.449 (male = 24.08 +/- 4.489 and female = 24.50 +/- 4.501) and the mean age of control subjects 24.91 +/- 4.671 (male = 24.95 +/- 4.726 and female = 24.88 +/- 4.721).

The values for IOP, CCT and CD in DS patients were between 9-20, 441-518 and 9.1-10.9 respectively while values for IOP, CCT and CD in control subjects were between 10-20, 540-560, 11.5- 11.9 respectively. The mean values for IOP, CCT and CD in Down syndrome persons was 13.83 +/- 3.735, 478.34 +/- 23.268, 10.4128 +/- 0.62120 while the mean value for IOP, CCT and CD in control subjects was 14.50 +/- 3.358, 545.74 +/- 17.343, 11.7043 +/- 0.10532 respectively.

From SPSS version 23 data output, data analysis using the Independent Sample T test at 0.05 level of significance and 95% confidence interval revealed for IOP a P value of 0.567. Since  $P (0.567) > 0.05$ , the Intraocular Pressure (IOP) of people with Down Syndrome and a control group are the same. For CCT it revealed a P value of 0.001. Since  $P (0.001) < 0.05$ , the Central Corneal Thickness (CCT) of people with Down Syndrome and a control group are not the same. For CD it revealed a P value of 0.001.

Since  $P(0.000) < 0.05$ , the Corneal Diameter (CD) of people with Down Syndrome and a control group are not the same.

Persons with Down syndrome had a decreased Central corneal thickness and Corneal diameter compared with the control subjects. Decreased CCT may give an artificially low intraocular pressure measurement according to Evereklioglu *et al* (2002), although there was no significant difference in the IOP of Down syndrome persons and control subjects.

## **5.1 CONTRIBUTION TO KNOWLEDGE**

This study adds to the existing literature to provide information on Intraocular pressure (IOP), Central corneal thickness (CCT) and Corneal diameter (CD) and since persons with Down syndrome had a decreased CCT and CD compared with the control subjects, these must be considered when developing approaches for keratometric treatment of patients with Down syndrome.

## **CONCLUSION**

In conclusion, the results of this research showed that there was no significant difference between the Intraocular pressure of Down syndrome persons and Intraocular pressure of normal/control subjects. However, there was decrease in the Central Corneal Thickness and Corneal Diameter of Down syndrome individuals when compared with that of normal/control subjects.

### **Ethical Approval and Consent**

The approval of this research was obtained from the ethics committee of the Department of Optometry, Federal University of Technology. The participants consent was solicited from the guardian and coordinators of the subjects after clear explanation of the study and the purpose for which the research was to be conducted had been made clear to them.

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