Role of Visual Acuity & Contrast Sensitivity in Early Diagnosis of Cognitive Impairment in Parkinson's Disease

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Abstract: The study aims to evaluate the role of visual acuity and contrast sensitivity in early diagnosis of cognitive impairment in Parkinson's disease. This cross sectional study was performed us- ing validated assessments on cognitive function using Mini Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA). Visual acuity was assessed using LogMAR and contrast sensitivity using the Pelli-Robson test. Anxiety and depression were assessed using the Hospital Anxiety and Depression Scale (HADS). One hundred patients presenting to the Neurology department for complaints satisfying the criteria for Parkinson's disease at Saveetha Medical College and Hospital were randomly selected. The visual acuity and contrast sensitivity was found to be decreased in patients with low MMSE and MoCA scores, suggestive of visual function being a marker for progression of cognitive impairment in Parkinson's disease. This could thereby be used in early diagnosis of dementia and in for- mulating a customised treatment plan for each individual. Parkinson's disease has a deleteri- ous effect on various aspects of a person's life, not just the motor functions. This in turn harms the day to day activities of the individuals, mainly the older age group and results in psychological disorders, like anxiety and depression. Therefore, this study aims to establish visual function as a marker for cognitive impairment in Parkinson's disease, with the hopes of improving the quality of life of patients with this disease, thus revamping their purpose and outlook of their lives.

Keywords: Parkinson's disease; Cognitive impairment; Dementia; MMSE; MoCA; Visual function; Visual acuity; LogMAR; Contrast sensitivity ; Pelli-Robson; Marker; Early diagno- sis; Anxiety; Depression; HADS; Quality of life.

1. INTRODUCTION

Parkinson's disease is a progressive neurological disorder, associated with reduced dopamine levels in the body. The progression of the disease varies from one person to another, owing to the diversity of the disease. This makes it difficult to arrive at an early diagnosis and thus also reduces the chances of a good prognosis.

More than the disease itself, it's the complications that we need to pay extreme attention to, as Parkinson's related complications are ranked as the 14th cause of death in the United States, by the CDC (Center for Disease Control and Prevention).

Be it physical complications, like tremors, bradykinesia, impaired posture and balance, or emotional repercussions such as humiliation, anger, anxiety and depression, all of these ef- fects of Parkinson's disease disables the patient from attaining the life goals he or she had aimed for, prior to Parkinson's, and end up taking a toll on the well being of the patient, di- rectly or indirectly affecting his outlook on life, thereby reducing the quality of his or her life.

Therefore, in order to ensure a good quality of life for patients with Parkinson's disease, it is imperative to understand the disease and its progression. Scientists are exploring methods to identify biomarkers for Parkinson's, that can lead to earlier diagnosis and more customized treatments to slow down the disease progression, hence reducing the risks of complications.

One of the most dreaded outcomes in Parkinson's, is dementia, the risks of which are highly increased, as a result of cognitive impairment. There is a growing body of evidence that Parkinson's patients with visual dysfunction are at a greater risk of dementia (1).

Visual complaints are usually not presented to the clinician when the patient turns up for a Parkinson's consultation, as it's given less importance as compared to the motor disorders. These visual symptoms and signs may also get overlooked by the practitioners.

However, many scholars and scientists suggest that visual acuity and contrast sensitivity could be the missing jigsaw puzzle piece that would give us an early diagnosis of cognitive impairment in Parkinson's disease. However, not much satisfactory data is available to sub- stantiate the same.

Therefore, this study aims at proving the above said theory correct, by establishing a relation- ship between the visual acuity & contrast sensitivity observations of patients with Parkinson's disease and the MOCA & MMSE scores that assess the cognitive functions of the brain.

A strong link between the two would assure that, in Parkinson's patients with poor visual function, visual acuity and contrast sensitivity can be used as markers of imminent cognitive impairment.

2. METHODOLOGY MATERIALS & METHODS

Mini Mental State Examination (MMSE)

The Mini Mental State Examination (MMSE) is a 30-point test that is used to measure cogni- tive impairment in older adults. It includes tests of orientation, attention, memory, language and visual-spatial skills. The official total score for the MMSE are computer generated. The MMSE asks questions to ascertain cognitive status. Responses are scored: 0 - incorrect, 1 - correct, 6 - item administered, participant does not answer, 9 - test item not administered, un- known. When a participant is incapacitated by blindness, has a functional disability, is illiter- ate, or is otherwise unable to respond to a question, the interviewer should specify the prob- lem and questions involved. The exception of scoring 6 for no response. is if the patient is in a comatose condition.

Interpretation of the scores:

25-30 : Degree of cognitive impairment is questionably significant 20-25 : Mild cognitive impairment

10-20 : Moderate cognitive impairment 0-10 : Severe cognitive impairment

Montreal Cognitive Assessment (MoCA)

The Montreal Cognitive Assessment (MoCA) is a brief 30-question test that takes around 10 to 12 minutes to complete and helps assess people for dementia. It was published in 2005 by a group at McGill University working for several years at memory clinics in Montreal. It evaluates different types of cognitive abilities like orientation, delayed recall, visual-spatial ability, attention, language, abstraction, animal naming and clock-drawing test.

Interpretation of the scores:

≤ 23 : Pathological

24-26: Undecided, further assessments required

≥ 27 : Healthy

VISUAL ACUITY - LogMAR

The term LogMAR is an acronym for the Logarithm of the Minimum Angle of Resolution. LogMAR charts have a number of advantages over Snellen charts and have become the gold standard method for assessing visual acuity. The letter size is described in LogMAR units where LogMAR 0.00 is equivalent to 6/6 (20/20) and LogMAR 1.00 is equivalent to 6/60 (20/200). Each letter has a score value of 0.02 log units. Since there are 5 letters per line, the total score for a line on the LogMAR chart represents a change of 0.1 log units.

Calculating the score using formula:

1) LogMAR VA = 0.1 + LogMAR value of best line read - 0.02*(number of optotypes read)

2) LogMAR VA = LogMAR value of best line read + 0.02*(number of optotypes missed)

CONTRAST SENSITIVITY - PELLI ROBSON

Pelli-Robson test measures contrast sensitivity using a single large letter size (20/60 opto- type), with contrast varying across groups of letters. Specifically, the chart uses letters (6 per line), arranged in groups whose contrast varies from high to low. Patients read the letters, starting with the highest contrast, until they are unable to read two or three letters in a single group. Each group has three letters of the same contrast level, so there are three trials per con- trast level. The subject is assigned a score based on the contrast of the last group in which two or three letters were correctly read.

Interpretation of the score:

The score, a single number, is a measure of the subject's log contrast sensitivity.

2.0 : Normal contrast sensitivity of 100 percent

< 2.0 : Poorer contrast sensitivity.

<1.5 : Visual impairment

<1.0 : Visual disability.

Hospital Anxiety and Depression Scale (HADS)

The Hospital Anxiety and Depression Scale (HADS) was devised to measure anxiety and de- pression in a general medical population of patients. It has become a popular tool, for clinical practice and research. It comprises seven questions for anxiety and seven questions for de- pression, and takes 2–5min to complete. Although the anxiety and depression questions are interspersed within the questionnaire, it is vital that these are scored separately.

Interpretation of the scores:

0-7: Normal

8-10 : Borderline abnormal 11-21 : Abnormal

Participants

One hundred patients presenting to the Neurology department for complaints satisfying the criteria for Parkinson's disease at Saveetha Medical College and Hospital were selected.

Consent Procedures

This study was reviewed and approved by IEC.

Participants were involved in the study as part of a health promotion project. This was ex- plained to the Directors, Professors, and students of the institution. Information sheet on the intentions, methods and procedure of the study were circulated to all the participants. Written informed consent was obtained from all students before their enrolment in the study.

Participants were assured their information and responses would be kept confidential and would not be disclosed under any circumstances.

Procedure:

The participants were taken for clinical evaluation of their cognitive function. This was per- formed using MMSE (Mini Mental State Examination) and MoCA (Montreal Cognitive As-

sessment), after both these assessments were verified by two neurologists and one general practitioner. Once their scores were calculated, the participants were taken to the Ophthal- mology department for assessing their visual acuity and contrast sensitivity. They were eval- uated using LogMAR and Pelli-Robson charts respectively. Then their scores were noted down and compared with their MMSE and MoCA scores. The participants were also screened for anxiety and depression using the Hospital Anxiety and Depression Scale (HADS). The results were tabulated and analysed using IBM SPSS software.

Study design:

This study was performed by a series of clinical evaluation of the general cognitive function by Mini Mental State Examination (MMSE) and Montreal Cognitive Assessment (MOCA). Visual acuity was assessed using LogMAR and contrast sensitivity using the Pelli-Robson test. Anxiety and depression were evaluated using the Hospital Anxiety and Depression Scale (HADS).

Sampling Method:

This study uses simple random sampling method

Study setting:

This study was conducted at Saveetha Medical College and Hospital , where patients were randomly sampled.

Inclusion criteria:

This study included patients diagnosed for Parkinson's disease by a neurologist at Neurology department of Saveetha Medical College and Hospital.

Exclusion criteria:

This study excluded patients with undiagnosed motor function disorders, and those patients who have not been properly diagnosed for Parkinson's by a neurologist.

Potential risks & benefits:

Risks are practically nil, except sparing their valuable time. Study data and confidentiality will have to be maintained while using the information for scientific purpose

Expected outcome:

The MMSE and MOCA scores will be low in Parkinson's patients with low visual function, i.e., in patients with decreased Visual acuity- logMar and decreased Contrast Sensitivity- Pel- li-Robson, suggestive of visual function being a marker for early diagnosis of cognitive im- pairment and thereby dementia, in Parkinson's disease.

3. RESULTS AND DISCUSSION

The scores from MMSE, MoCA, LogMAR, Pelli-Robson and HADS anxiety and depression, were tabulated and analysed using the IBM SPSS software.

The below table shows the mean, median, mode and standard deviations of all the data collected.

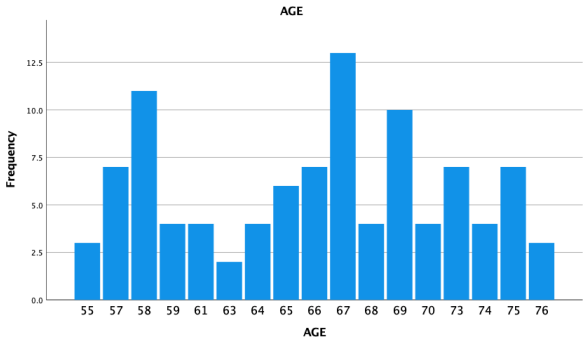
Statistics

		AGE	GENDER	YEARS OF EDUCATION	YEARS FROM DIAGNOSIS	LEVODOPA DOSE	MMSE SCORE	MoCA SCORE	HADS ANXIETY SCORE	HADS DEPRESSION SCORE	VISUAL ACUITY–logMAR	CONTRAST SENSITIVITY–PELLI ROBSON
N	Valid	100	100	100	100	100	100	100	100	100	100	100
	Missing	0	0	0	0	0	0	0	0	0	0	0
Mean		65.89	1.35	13.26	7.17	409.00	23.63	23.63	12.80	12.36	.398	1.702
Median		67.00	1.00	13.00	6.00	400.00	22.00	22.00	13.00	11.00	.400	1.700
Mode		67	1	12	5	400	22	21	10	9	.5	1.6
Std. Deviation		6.045	.479	1.750	3.075	70.489	3.302	2.873	3.191	3.483	.1570	.1570
Variance		36.543	.230	3.063	9.456	4968.687	10.902	8.256	10.182	12.132	.025	.025
Range		21	1	7	11	250	9	7	11	11	.5	.5
Minimum		55	1	10	3	300	20	21	9	8	.1	1.5
Maximum		76	2	17	14	550	29	28	20	19	.6	2.0
Percentiles	25	59.50	1.00	12.00	5.00	350.00	21.00	21.00	10.00	9.00	.300	1.600
	50	67.00	1.00	13.00	6.00	400.00	22.00	22.00	13.00	11.00	.400	1.700
	75	69.75	2.00	14.00	10.00	450.00	27.00	27.00	15.00	15.00	.500	1.800

The tables below show the frequency distribution of the following:

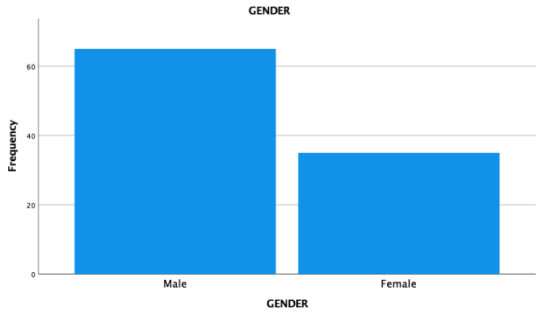
AGE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	55	3	3.0	3.0	3.0
	57	7	7.0	7.0	10.0
	58	11	11.0	11.0	21.0
	59	4	4.0	4.0	25.0
	61	4	4.0	4.0	29.0
	63	2	2.0	2.0	31.0
	64	4	4.0	4.0	35.0
	65	6	6.0	6.0	41.0
	66	7	7.0	7.0	48.0
	67	13	13.0	13.0	61.0
	68	4	4.0	4.0	65.0
	69	10	10.0	10.0	75.0
	70	4	4.0	4.0	79.0
	73	7	7.0	7.0	86.0
	74	4	4.0	4.0	90.0
	75	7	7.0	7.0	97.0
	76	3	3.0	3.0	100.0
	Total	100	100.0	100.0	



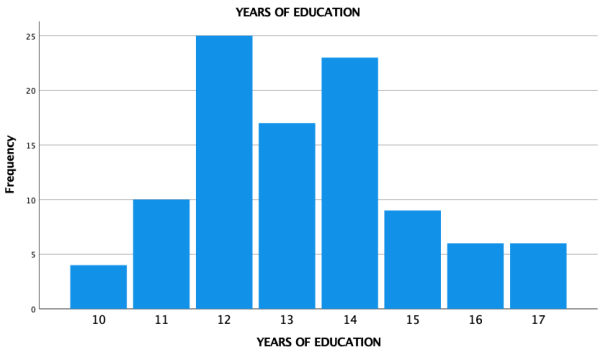
GENDER

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	65	65.0	65.0	65.0
	Female	35	35.0	35.0	100.0
	Total	100	100.0	100.0	



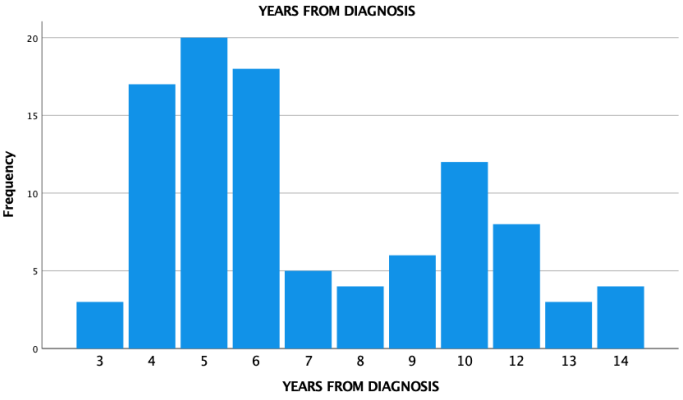
YEARS OF EDUCATION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	4	4.0	4.0	4.0
	11	10	10.0	10.0	14.0
	12	25	25.0	25.0	39.0
	13	17	17.0	17.0	56.0
	14	23	23.0	23.0	79.0
	15	9	9.0	9.0	88.0
	16	6	6.0	6.0	94.0
	17	6	6.0	6.0	100.0
	Total	100	100.0	100.0	



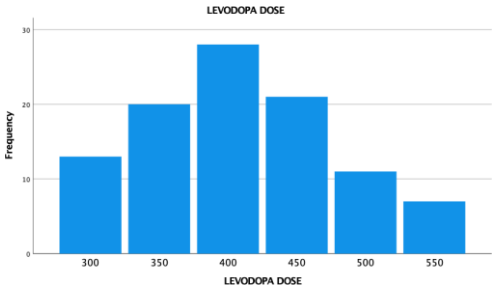
YEARS FROM DIAGNOSIS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	3	3.0	3.0	3.0
	4	17	17.0	17.0	20.0
	5	20	20.0	20.0	40.0
	6	18	18.0	18.0	58.0
	7	5	5.0	5.0	63.0
	8	4	4.0	4.0	67.0
	9	6	6.0	6.0	73.0
	10	12	12.0	12.0	85.0
	12	8	8.0	8.0	93.0
	13	3	3.0	3.0	96.0
	14	4	4.0	4.0	100.0
	Total	100	100.0	100.0	



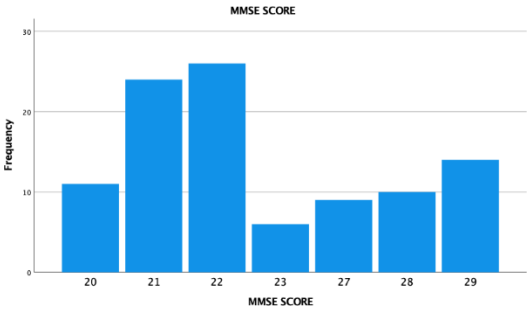
LEVODOPA DOSE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	300	13	13.0	13.0	13.0
	350	20	20.0	20.0	33.0
	400	28	28.0	28.0	61.0
	450	21	21.0	21.0	82.0
	500	11	11.0	11.0	93.0
	550	7	7.0	7.0	100.0
	Total	100	100.0	100.0	



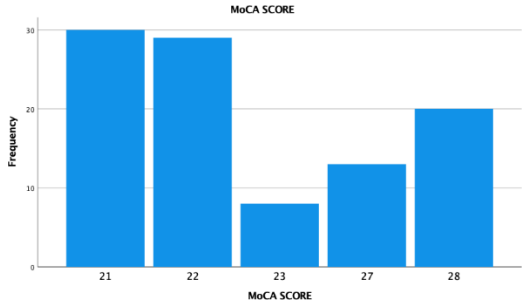
MMSE SCORE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20	11	11.0	11.0	11.0
	21	24	24.0	24.0	35.0
	22	26	26.0	26.0	61.0
	23	6	6.0	6.0	67.0
	27	9	9.0	9.0	76.0
	28	10	10.0	10.0	86.0
	29	14	14.0	14.0	100.0
	Total	100	100.0	100.0	



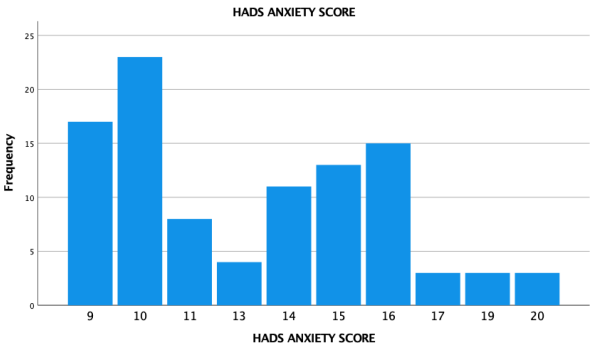
MoCA SCORE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21	30	30.0	30.0	30.0
	22	29	29.0	29.0	59.0
	23	8	8.0	8.0	67.0
	27	13	13.0	13.0	80.0
	28	20	20.0	20.0	100.0
	Total	100	100.0	100.0	



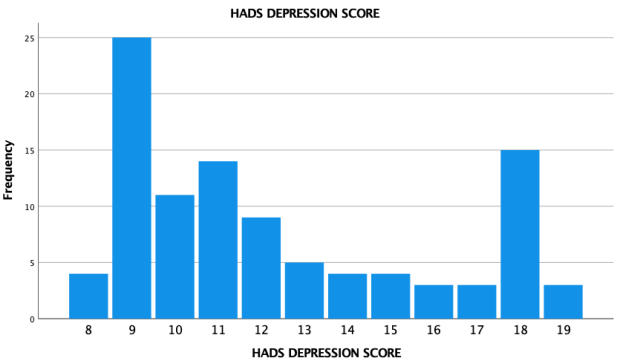
HADS ANXIETY SCORE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	9	17	17.0	17.0	17.0
	10	23	23.0	23.0	40.0
	11	8	8.0	8.0	48.0
	13	4	4.0	4.0	52.0
	14	11	11.0	11.0	63.0
	15	13	13.0	13.0	76.0
	16	15	15.0	15.0	91.0
	17	3	3.0	3.0	94.0
	19	3	3.0	3.0	97.0
	20	3	3.0	3.0	100.0
	Total	100	100.0	100.0	



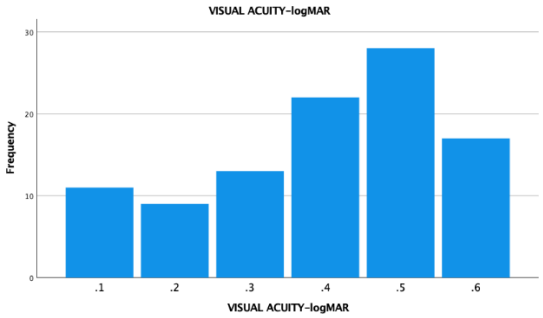
HADS DEPRESSION SCORE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	8	4	4.0	4.0	4.0
	9	25	25.0	25.0	29.0
	10	11	11.0	11.0	40.0
	11	14	14.0	14.0	54.0
	12	9	9.0	9.0	63.0
	13	5	5.0	5.0	68.0
	14	4	4.0	4.0	72.0
	15	4	4.0	4.0	76.0
	16	3	3.0	3.0	79.0
	17	3	3.0	3.0	82.0
	18	15	15.0	15.0	97.0
	19	3	3.0	3.0	100.0
	Total	100	100.0	100.0	



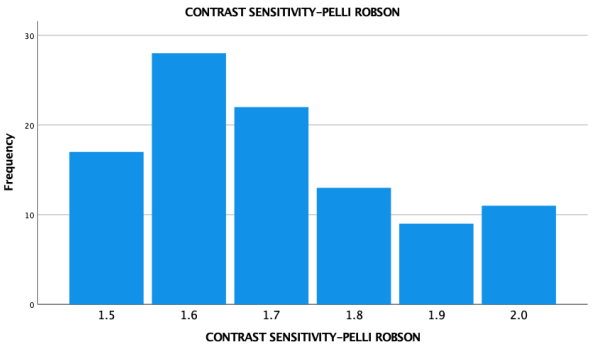
VISUAL ACUITY-logMAR

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.1	11	11.0	11.0	11.0
	.2	9	9.0	9.0	20.0
	.3	13	13.0	13.0	33.0
	.4	22	22.0	22.0	55.0
	.5	28	28.0	28.0	83.0
	.6	17	17.0	17.0	100.0
	Total	100	100.0	100.0	



CONTRAST SENSITIVITY-PELLI ROBSON

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.5	17	17.0	17.0	17.0
	1.6	28	28.0	28.0	45.0
	1.7	22	22.0	22.0	67.0
	1.8	13	13.0	13.0	80.0
	1.9	9	9.0	9.0	89.0
	2.0	11	11.0	11.0	100.0
	Total	100	100.0	100.0	



The MMSE, MoCA, visual acuity and contrast sensitivity are correlated and their means are com- pared in the following tables.

Descriptive Statistics

	Mean	Std. Deviation	N
VISUAL ACUITY-logMAR	.398	.1570	100
CONTRAST SENSITIVITY-PELLI ROBSON	1.702	.1570	100
MMSE SCORE	23.630	3.3018	100
MoCA SCORE	23.630	2.8733	100

Pearson Correlation

		MoCA SCORE	VISUAL ACUITY-logMAR
MoCA SCORE	Pearson Correlation	1	-.895**
	Sig. (2-tailed)		<.001
	N	100	100
VISUAL ACUITY-logMAR	Pearson Correlation	-.895**	1
	Sig. (2-tailed)	<.001	
	N	100	100

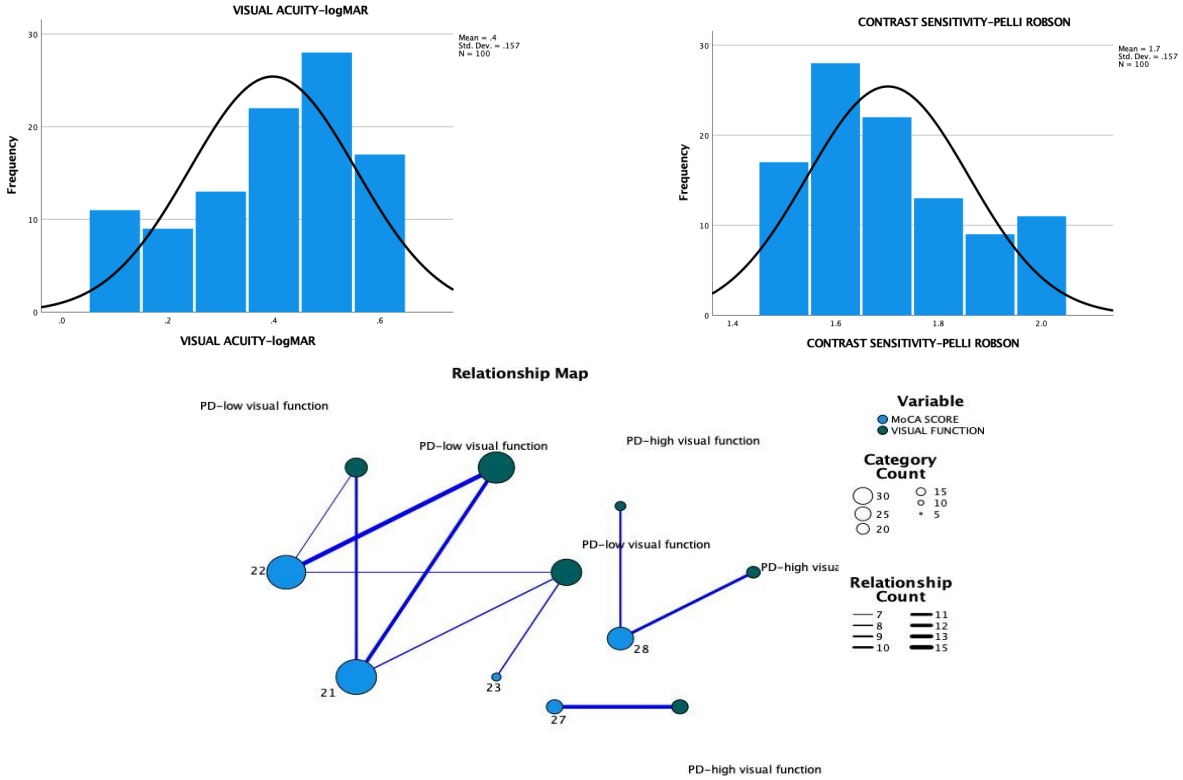
**. Correlation is significant at the 0.01 level (2-tailed).

According to the Pearson correlation, the 2-tailed significance is < 0.01, and r = - 0.895

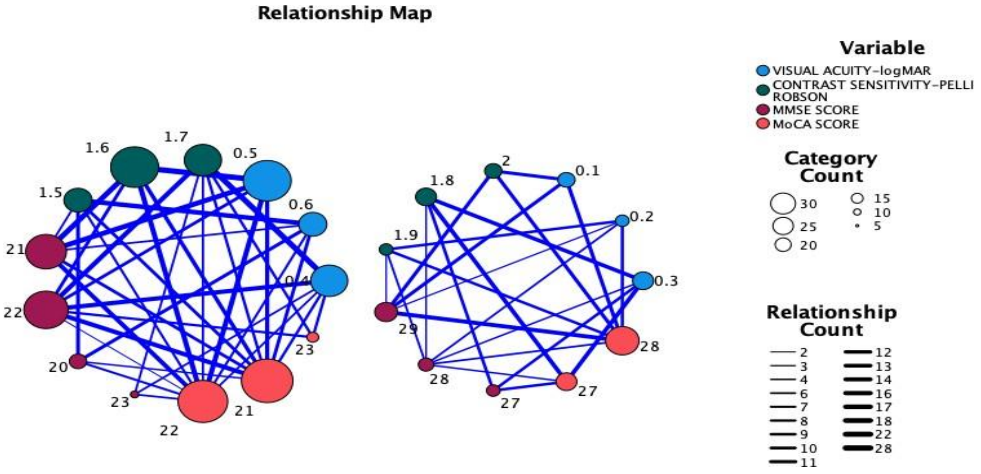
2-Tailed Significance

Control Variables			VISUAL ACUITY-logMAR	CONTRAST SENSITIVITY-PELLI ROBSON
MMSE SCORE & MoCA SCORE	VISUAL ACUITY-logMAR	Correlation	1.000	-1.000
		Significance (2-tailed)	.	.000
		df	0	96
	CONTRAST SENSITIVITY-PELLI ROBSON	Correlation	-1.000	1.000
		Significance (2-tailed)	.000	.
		df	96	0

When 2-tailed significance test was performed, the correlation coefficient was found to be - 1, a sig- nificant correlation, denoting that there is a relationship between cognitive impairment and visual function.



The relationship map between MoCA scores and Visual function, depicts that Parkinson's patients with low visual function tend to have a higher level of cognitive impairment, and those with a high visual function have low cognitive impairment levels.



CONCLUSION:

Based on the statistical analysis done, it has been established that in Parkinson's patients with low visual acuity and low contrast sensitivity, the cognitive function is also affected, that may result in dementia in the near future. Therefore, visual function can be used as a marker to diagnose dementia in Parkinson's disease, in the early stages itself, ensuring a good quality of life for the patients.

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