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THE EFFECT OF PSYCHOLOGICAL STATUS ON COGNITIVE PERFORMANCE AMONG PATIENTS WITH PARKINSON'S DISEASE

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ABSTRACT

Background: Parkinson's disease (PD) is considered the second most popular neurodegenerative disorder in the world. People diagnosed with Parkinson's disease (PD) have reported a decline in cognitive abilities, this also has been observed by their caregivers. Mild cognitive impairment affected nearly 20 to 50% of PD people, and studies show dementia in approximately up to 80% of people with PD. The most common cognitive impairments associated with PD are: Paying attention, planning, concentrating on events, solving complex problems, following a complex conversation, or even quickly form ideas and in some cases remembering events or details of events. It is noteworthy that depression has been reported in several cases of Parkinson's. ***Method:*** This study includes 20 PD patients with psychological problems and 20 healthy controls. They were gathered from King Fahd Medical City Hospital in Riyadh. Statistical methods used are frequencies & percentages, mean and standard deviation, independent sample T-test, effect size and eta squared (□2). The statistical package for Social Science (SPSS V.26) was used for manipulating and analyzing the data. ***Results:*** The results show that there is a significant difference in MMSE, DIGIT SPAN (FORWARD), STROOP TEST (Time), STROOP TEST (Error), TMT (A), TMT (B) and HADS (DEPRESSION) between patients with psychological problems and the healthy control group. But there is no significant difference in DIGIT SPAN (BACKWARD) and HADS (ANXIETY) between patients with PD and the healthy control group. ***Conclusions:*** In conclusion, this study is the first study in the Arab countries and the Kingdom of Saudi Arabia specifically, that explored the psychological effect on cognitive functions in Parkinson's disease in Saudi society.

KEYWORDS: Parkinson's disease, Saudi Arabia, cognitive performance.

INTRODUCTION

Parkinson's disease (PD) is considered the second most popular neurodegenerative disorder in the world. The overall prevalence of PD is estimated to be approximately 0.3% of the total population in industrialized countries.[1] Parkinson's disease is a progressive neurodegenerative and chronic disorder. This disorder is categorized as a synucleinopathy and distinguished by motor and non-motor features.[2,3]

Parkinson's is pathologically heterogeneous, with the main and most common pathological substrates associated with differences in the pre-synaptic protein α-synuclein or microtubule-binding protein tau. In idiopathic Parkinson's disease (PD), α-synuclein accumulates in the perikarya neurons (Lewy bodies) and neuronal processes (Lewy nerves). The disease process is multifocal and includes selected nerve cells of the central nervous system and neurons of the peripheral autonomic nervous system. The specific group of affected neurons determines the non-motor clinical presentations. Multiple system atrophy (MSA) is the other major type of alpha-synucleopathy. It is also associated with autonomic dysfunction and in some cases cerebellar signs. The characteristic histopathological feature of MSA is the accumulation of α-synuclein within glial cytoplasmic inclusions (GCI). The most common type of Parkinson's disease is progressive supranuclear palsy (PSP), which is clinically associated with severe postural instability that leads to premature falls. The tau pathology of PSP also affects both neuron and glial cells.[4]

The pathologic character that associates with symptoms and signs of PD is a neuronal loss in the substantia nigra with dopaminergic denervation of the striatum. Neuronal degeneration in the substantial nigra preferably affects the ventrolateral cell group that projects to posterolateral putamen and is accompanied by forming Lewy bodies consisting of aggregated a-synuclein. Some PD patients are found at autopsy to have other pathologic processes, like progressive supranuclear palsy, multiple system atrophy, and cerebrovascular disease (vascular Parkinsonism).[5]

The most common risk factors for developing PD are genetic factors, aging, and environmental factors. The incidence and prevalence of Parkinson's disease are associated with advanced age,[6] as PD affects almost 1-2% of persons over 65 years of age.[3] Whereas, the development of Parkinson's traits before the age of 40 is known as Early-onset Parkinson's disease (EOPD), and it has been estimated to be about 3-5% of all Parkinson's cases.[6] 6 million people and more worldwide suffer from Parkinson's disease.[7]

Genetic factors play an important role in the occurrence of Parkinson's disease. As some results of twin studies indicated the presence of a genetic component of the disease. At the same time, this does not mean that people who carry some genetic mutations will inevitably suffer, but it increases the likelihood of this development at a slightly higher rate than it is in the rest of the population. Approximately 5% of patients with clinical symptoms of Parkinson's disease have a clear positive family history. Besides, the genes that contribute to Parkinson's disease have been identified through the detection of mutations in two of the genes that can cause Senoclin and LRRK2 or recessive genotypes (Parkins, PINK1, and DJ1) of the disease.[8] Some studies have shown that environmental factors are one of the most important risk factors for Parkinson's disease. Since PD is particularly prevalent in industrialized countries, it is a finding that confirms the participation of industrial toxins in causing the disease. Environmental factors include pesticides, head trauma, diet, rural living, drinking well water, smoking, and infections.[8]

People diagnosed with Parkinson’s disease (PD) have reported a decline in cognitive abilities, this also has been observed by their caregivers. Mild cognitive impairment affected nearly 20 to 50% of PD people, and studies show dementia in approximately up to 80% of people with PD.[9] Cognitive impairment associated with PD, characterized by spatial vision dysfunction, prevalent executive deficits, and relatively unaffected memory. Previous studies that investigated cognitive decline in PD were heterogeneous. Furthermore, cognitive impairments in PD are very based on the severity and progression. This cognitive decline ranges from subtle cognitive changes to severe deficits. The patient may begin with mild cognitive impairment (MCI) and progress dementia (PDD).[9,10] The most common cognitive impairments associated with PD are: Paying attention, planning, concentrating on events, solving complex problems, following a complex conversation, or even quickly form ideas and in some cases remembering events or details of events.[11] Cognitive decline in PD is linked with advanced disease progression, age, and male sex.[12]

Psychological symptoms, such as depression, anxiety, hallucination, delusion, compulsive and impulsive behaviors, cognitive dysfunction, and apathy and anhedonia appear in most PD Patients. Cognitive decline and depression are very popular, and they get worse as the disease advances and it results in an increase in disability and poor quality of life.[13]

It is noteworthy that depression has been reported in several cases of Parkinson's.[14] The incidence of clinically significant depression in patients with PD is as high as 35%, thus,

various researches indicate that depression is the major factor affecting the life quality in PD.[15]

The features of depression related to PD are different from those represented in major depressive disorder. Characteristics predominant in patients with PD include irritability, lack of energy, and psychomotor slowing; feelings of guilt or failure are absent. Several factors, such as movement complications, may contribute to depression in Parkinson's.[16] Studies showed that symptoms of depression in the PD group were fatigue, sleep disorders, and difficulty working. Moreover, episodic memory and attention were the two cognitive areas most affected by symptoms of depression. Understanding the specific features in PD and Mild Cognitive impairment (MCI), might simplify suitable care of the patients. Thus, this study suggested that future studies should include patients with PD and MCI, and depression, allowing characterization of their neuropsychological profile.[17]

Chronic stress from anxiety may damage compensatory processes in patients with PD and elucidate the cognitive impairments specifically in working memory and attention seen in PD patients with anxiety.[18] It has also been noticed that a compensatory striatal mechanism may be reflected by activation within the putamen to preserve the working memory in its normal performance in patients with PD, but losing this compensatory activation has been shown to contribute to poor working memory performance. Anxiety in mild PD has been linked to reduced putamen dopamine uptake, which becomes more extensive as the disease progresses.

This further supports the notion that anxiety may disrupt compensatory striatal mechanisms as well, providing another possible explanation for the cognitive impairments observed in PD patients with anxiety.[18]

Parkinson's disease (PD) patients are often treated using dopamine medications. It is known that dopamine improves motor and some non-motor symptoms, such as depression.[19] Dopamine deficiency acts as the main reason for the high frequency of anxiety and depression in PD. For instance, some studies proved that anxiety and depression in PD are associated with decreasing dopamine and noradrenaline innervation in the limbic system.[20] Both psychological difficulties and cognitive impairment can be challenging as motor difficulties, if not more, to PD patients and their caregivers and greatly affect the patient's quality of life.[21] Subsequently, this study is aimed at investigating the effect of psychological status on cognitive performance among Parkinson’s patients.

To our knowledge, in the Arab countries and the Kingdom of Saudi Arabia specifically, there were no studies that explored the psychological effect on cognitive functions in Parkinson's disease in Saudi society. Therefore, this study will be the first to examine these variables in the Saudi population.

Research hypotheses

A- There is a significant difference in cognitive functions between PD patients and healthy controls, at a significant level (α≤0.05).

1. There is a significant difference in the Mini-Mental State Examination (MMSE) between all PD patients and healthy controls, at a significant level (α≤0.05).
2. There is a significant difference in the Digit Span Test between all PD patients and healthy controls, at a significant level (α≤0.05).
3. There is a significant difference in the Trail Making Test (TMT) between all PD patients and healthy controls, at a significant level (α≤0.05).
4. There is a significant difference in the Stroop Test between all PD patients and healthy controls, at a significant level (α≤0.05).
5. There is a significant difference in the Hospital Anxiety and Depression Scale (HADS) between all PD patients and healthy controls, at a significant level (α≤0.05).

B- There is a significant difference in cognitive functions between PD patients with depression and without depression.

1. There is a significant difference in the Mini-Mental State Examination (MMSE) between PD patients with depression and without depression, at a significant level (α≤0.05).
2. There is a significant difference in the Digit Span Test between PD patients with depression and without depression, at a significant level (α≤0.05).
3. There is a significant difference in the Trail Making Test (TMT) between PD patients with depression and without depression, at a significant level (α≤0.05).
4. There is a significant difference in the Stroop Test between PD patients with depression and without depression, at a significant level (α≤0.05).

   5-There is a significant difference in the Hospital Anxiety and Depression Scale (HADS) between PD patients with depression and without depression, at a significant level (α≤0.05).

C- There is a significant difference in cognitive functions between PD patients with depression and healthy controls, at a significant level (α≤0.05).

1. There is a significant difference in the Mini-Mental State Examination (MMSE) between PD patients with depression and healthy controls, at a significant level (α≤0.05).
2. There is a significant difference in the Digit Span Test between PD patients with depression and healthy controls, at a significant level (α≤0.05).
3. There is a significant difference in the Trail Making Test (TMT) between PD patients with depression and healthy controls, at a significant level (α≤0.05).
4. There is a significant difference in the Stroop Test between PD patients with depression and healthy controls, at a significant level (α≤0.05).
5. There is a significant difference in the Hospital Anxiety and Depression Scale (HADS) between PD patients with depression and healthy controls, at a significant level (α≤0.05).

D- There is a significant difference in cognitive functions between PD patients with anxiety and without anxiety, at a significant level (α≤0.05).

1. There is a significant difference in the Mini-Mental State Examination (MMSE) between PD patients with anxiety and without anxiety, at a significant level (α≤0.05).
2. There is a significant difference in the Digit Span Test between PD patients with anxiety and without anxiety, at a significant level (α≤0.05).
3. There is a significant difference in the Trail Making Test (TMT) between PD patients with anxiety and without anxiety, at a significant level (α≤0.05).
4. There is a significant difference in the Stroop Test between PD patients with anxiety and without anxiety, at a significant level (α≤0.05).
5. There is a significant difference in the Hospital Anxiety and Depression Scale (HADS) between PD patients with anxiety and without anxiety, at a significant level (α≤0.05).

E- There is a significant difference in cognitive functions between PD patients with anxiety and healthy controls, at a significant level (α≤0.05).

1. There is a significant difference in the Mini-Mental State Examination (MMSE) between PD patients with anxiety and healthy controls, at a significant level (α≤0.05).
2. There is a significant difference in the Digit Span Test between PD patients with anxiety and healthy controls, at a significant level (α≤0.05).
3. There is a significant difference in the Trail Making Test (TMT) between PD patients with anxiety and healthy controls, at a significant level (α≤0.05).
4. There is a significant difference in the Stroop Test between PD patients with anxiety and healthy controls, at a significant level (α≤0.05).

5. There is a significant difference in the Hospital Anxiety and Depression Scale (HADS) between PD patients with anxiety and healthy controls, at a significant level ($\alpha \leq 0.05$).

Research Methodology

The variable used in this study consists of two variables that are as follows:

- ☒ Independent variables include patients with PD.
- ☒ Dependent variables include:

1. **Mini-Mental State Examination (MMSE):** is a 30-point questionnaire that is used extensively in clinical and research settings to screen cognitive impairment among the elderly; it includes tests of orientation, attention, memory, language, and visual-spatial skills.[22]

2. **Digit Span:** is a subtest of both the Wechsler adult intelligence scale (WAIS) and the Wechsler Memory Scale (WMS). Subjects were given a sequence of numbers to read and asked to repeat the same sequence back to the examiner in order (Forward span) or in reverse order (backward span). Forward span captures attention efficiency and capacity. Backward span is an executive task particularly dependent on working memory.[23]

3. **Trail making test (TMT):** assesses the following:

Part A: visuo-motor tracing.

Part B: divided attention and cognitive flexibility.[23]

4. **Stroop test:** is a neuropsychological test containing three parts A and B to assess attention and concentration and C to assess the ability to proceed with shifting and responding inhibition.[24]
5. **Hospital anxiety & depression scale (HADS):** a scale for detecting states of depression and anxiety in the setting of a hospital medical outpatient clinic. The anxiety and depression of the emotional disorder.[25]

Target population

The population of this study consists of all patients with PD**,** based on medical diagnosis taken from the files and based on PD diagnosis criteria such as (resting tremor, rigidity, bradykinesia, and postural instability), Saudis, males and females, and without any neurological diseases. However, non-Saudis, those with neurological diseases, and those who did not have a clear diagnosis of PD were excluded from this study.

Research sample

The sample of this study includes 40 participants, (20 PD patients with psychological problems and 20 healthy controls) who participated in this study. They were gathered from King Fahd Medical City Hospital in Riyadh. The demographic characteristics of the sample are shown in Table 1**:**

Table (1): the demographic characteristics of the study sample.

		Group		P-value
		The control group N=20	PD Group N=20	
Gender	Male	11	14	.327
		55.0%	70.0%	
	Female	9	6	
		45.0%	30.0%	
Education	Primary	2	2	1.00
		10.0%	10.0%	
	Intermediate	3	3	
		15.0%	15.0%	
	High school	4	4	
		20.0%	20.0%	
	University	11	11	
		55.0%	55.0%	
Age	Mean	57.6	59.85	0.482
	Std.D	10.10	9.95	

Statistical Analysis

To achieve the research goal, the researcher used the statistical package for Social Science (SPSS V.26) for manipulating and analyzing the data.

Statistical methods are as follows:

1. Frequencies & Percentages to describe Demographic Information for the research sample**.**
2. Mean and Standard Deviation to show how much variation or dispersion exists from the mean
3. Independent sample T-test to test the difference in neuropsychological assessments between the control group and the PD group**.**
4. Effect size and eta squared (η2), to find out the size of the effect of psychological status on cognitive performance among patients with Parkinson's disease.

$$\eta^2 = \frac{T^2}{T^2 + df} = \frac{T^2}{T^2 + (n_1 + n_2 - 2)}$$

Where T is the test value of the independent sample t-test, df is the degrees of freedom, n1, n2 sample size for each group.

RESULTS

Hypothesis testing

A-1: There is a significant difference in the Mini-Mental State Examination (MMSE) between all PD patients and the healthy control group, at a significant level ($\alpha \leq 0.05$).

To test the hypothesis, we use the independent sample t-test to test the difference between all PD patients and healthy control in the mean of MMSE**.**

The results in table (2) show that the mean MMSE in the healthy control group = 28.55 with standard deviation = 1.47, and the mean MMSE in all PD patients = 24.85 with standard deviation = 3.39. The absolute value of calculated t-test (t-test =4.477) which is greater critical value (t-critical = 2.02) at a degree of freedom of (38) and at 0.05 level of significance and the (p-value = 0.000 < 0.05). As a result, there is a significant difference in MMSE between all PD patients and the healthy control group.

Table (2): Independent sample t-test to test the difference between PD patients and the healthy control group in the mean of MMSE.

Group	N	Mean	S. D	T-test	df.	P-value	η2
The control group	20	28.55	1.47	4.477	38	.000**	.345
PD Group	20	24.85	3.39				

**the difference is significant at 0.01 level.

Effect size and eta squared (η2):

The effect size measures the significant difference between the mean scores of two groups, and we can calculate the eta squared (**η2**) as follows:

$$\eta^2 = \frac{T^2}{T^2 + df} = \frac{T^2}{T^2 + (n_1 + n_2 - 2)}$$

Where T is the test value of the independent sample t-test, df is the degrees of freedom.
And the effect size divided into three levels:

A-1. Effect size is small if $0.01 < \eta^2 < 0.06$

A-2. Effect size is moderate if $0.06 < \eta^2 < 0.14$

A-3. Effect size is high if $\eta^2 > 0.14$

From table No (2) the value of $^2\eta$ =0.345 means that the effect of psychological status on Mini-Mental State Examination (MMSE) among patients with Parkinson's disease influences 34.5% which is a high effect.

A2: There is a significant difference in the DIGIT SPAN between all PD patients and the healthy control group, at a significant level ($\alpha \leq 0.05$).

To test the hypothesis, we use an independent sample t-test to test the difference between all PD patients and the healthy control group in the mean of DIGIT SPAN**.**

The results in table (3) show that the mean DIGIT SPAN (FORWARD) in the healthy control group = 5.45 with standard deviation =1.0, and the mean DIGIT SPAN (FORWARD) in all PD patients = 4.65 and with standard deviation = 0.93**.**

The absolute value of calculated t-test (t-test =2.617) which is a greater critical value (t-critical = 2.02) at a degree of freedom of (38) and at 0.05 level of significance and the (p-value = 0.013 < 0.05)**.**

As a result, there is a significant difference in DIGIT SPAN (FORWARD) between patients with psychological problems and the healthy control group.

In addition, the results in table (3) show that the mean DIGIT SPAN (BACKWARD) in the healthy control group = 3.85 with standard deviation =0.88, and the mean DIGIT SPAN (BACKWARD) in patients with psychological problems = 3.45 with standard deviation = 0.76**.**

The absolute value of calculated t-test (t-test =1.544) which is less than (t-critical = 2.02) at degree of freedom (38) and at 0.05 level of significance and the (p-value = 0.131 > 0.05) **.**

As a result, there is no significant difference in DIGIT SPAN (BACKWARD) between patients with psychological problems and the healthy control group.

Table (3): Independent sample t-test to test the difference between patients with psychological problems and the healthy control group in the mean of DIGIT SPAN.

DIGIT SPAN	Group	N	Mean	S. D	T-test	df.	P-value	η2
FORWARD	The control group	20	5.45	1.00	2.617	38	.013*	.153
	PD Group	20	4.65	0.93				
BACKWARD	The control group	20	3.85	0.88	1.544	38	.131	.059
	PD Group	20	3.45	0.76				

*the difference is significant at 0.05 level.

Effect size and eta squared (η2):

From table No. (3) the value of $^{2}\eta$ =0.153 means that the effect of psychological status on Mini-Mental State Examination DIGIT SPAN (FORWARD) among patients with Parkinson's disease influences 15.3% which is a high effect. And the value of $^{2}\eta$ =0.059 means that the effect of psychological status on Mini-Mental State Examination DIGIT SPAN (BACKWARD) among patients with Parkinson's disease influences 5.9% which is a small effect.

A3: There is a significant difference in the STROOP TEST between patients with psychological problems and the healthy control group, at a significant level ($\alpha \leq 0.05$).

To test the hypothesis, we use an independent sample t-test to test the difference between patients with psychological problems and the healthy control group in the mean of STROOP TEST (Time)**.**

The results in table (4) show that the mean STROOP TEST (Time) in the healthy control group = 30.20 with standard deviation =14.28, and the mean STROOP TEST (Time) in patients with psychological problems = 44.34 with standard deviation = 18.34**.**

The absolute value of calculated t-test is (t-test =2.72) which is a greater critical value (t-critical = 2.02) at a degree of freedom of (38) and at 0.05 level of significance and the (p-value = 0.01 < 0.05).

As a result, there is a significant difference in STROOP TEST (Time) between patients with psychological problems and the healthy control group.

Also, the results in table (4) show that the mean STROOP TEST (Error) in the healthy control group = 1.1 with standard deviation =1.29, and the mean STROOP TEST (Error) in patients with psychological problems =3.60 with standard deviation =2.85**.**

The absolute value of calculated t-test (t-test =2.72) which is a greater critical value (t-critical = 2.02) at a degree of freedom of (38) and at 0.05 level of significance and the (p-value = 0.001 < 0.05).

As a result, there is a significant difference in STROOP TEST (Error) between patients with psychological problems and the healthy control group.

Table (4): Independent sample t-test to test the difference between patients with psychological problems and the healthy control group in the mean of STROOP TEST.

STROOP TEST	Group	N	Mean	S. D	T-test	df.	P-value	η2
Time	The control group	20	30.20	14.28	2.720	38	.010*	.163
	PD Group	20	44.34	18.34				
Error	The control group	20	1.10	1.29	3.572	38	.001**	.251
	PD Group	20	3.60	2.85				

*the difference is significant at 0.05 level **the difference is significant at 0.01 level.

Effect size and eta squared (η2):

From table No. (4) the value of $^{2}\eta$ =0.163 means that the effect of psychological status on STROOP TEST (Time) among patients with Parkinson's disease influences 16.3% which is a high effect, and the value of $^{2}\eta$ =0.251 means that the effect of psychological status on STROOP TEST (Error) among patients with Parkinson's disease influences 25.1% which is a high effect.

A4: There is a significant difference in the TMT between all PD patients and the healthy control group, at a significant level ($\alpha \leq 0.05$).

To test the hypothesis, we use an independent sample t-test to test the difference between patients with psychological problems and the healthy control group in the mean of TMT**.**

The results in table (5) show that the mean TMT (A) in the healthy control group = 89.40 with standard deviation = 31.96, and the mean TMT (A) in patients with psychological problems = 120.65 with standard deviation = 60.29**.**

The absolute value of calculated t-test is (t-test =2.048) which is a greater critical value (t-critical = 2.02) at a degree of freedom of (38) and at 0.05 level of significance and the (p-value = 0.048 < 0.05) **.**

As a result, there is a significant difference in TMT (A) between patients with psychological problems and patients without psychological problems.

Also, the results in table (5) show that the mean TMT (B) in the healthy control group = 111.45 with standard deviation = 37.14, and the mean TMT (B) in patients with psychological problems =234.5 with standard deviation =117.03**.**

The absolute value of calculated t-test is (t-test =4.482) which is a greater critical value (t-critical = 2.02) at degree of freedom (38) and at 0.05 level of significance and the (p-value = 0.000 < 0.05) **.**

As a result, there is a significant difference in TMT (B) between patients with psychological problems and the healthy control group.

Table (5): Independent sample t-test to test the difference between patients with psychological problems and the healthy control group in the mean of TMT.

TMT	Group	N	Mean	S. D	T test	df.	P- value	η2
A	The control group	20	89.40	31.96	2.048	38	.048*	.099
	PD Group	20	120.65	60.29				
B	The control group	20	111.45	37.14	4.482	38	.000**	0.346
	PD Group	20	234.50	117.03				

*the difference is significant at 0.05 level **the difference is significant at 0.01 level.

Effect size and eta squared (η2):

From table No. (5) the value of $^{2}\eta$ =0.099 means that the effect of psychological status on TMT (A) among patients with Parkinson's disease influences 9.9% which is a medium effect. And the value of $^{2}\eta$ =0.346 means that the effect of psychological status on TMT (B) among patients with Parkinson's disease influences 34.6% which is a high effect.

A5: There is a significant difference in the HADS between patients with PD and the healthy control group, at a significant level ($\alpha \leq 0.05$).

To test the hypothesis, we use an independent sample T-test, to test the difference between patients with PD and the healthy control group in the mean of HADS**.**

The results in table (6) show that the mean HADS (DEPRESSION) in the healthy control group = 2.25 with standard deviation =1.83, and the mean HADS (DEPRESSION) in patients with PD= 6.10 with standard deviation = 4.76**.**

The absolute value of calculated t-test is (t-test =3.378) which is greater critical value (t-critical = 2.02) at degree of freedom (38) and at 0.05 level of significance and the (p-value = 0.002 < 0.05).

As a result, there is a significant difference in HADS (DEPRESSION) between patients with PD and patients healthy control.

From table No. (6) the value of $^{2}\eta$ =0.231 means that the effect of psychological status on HADS (DEPRESSION) among patients with Parkinson's disease influences 23.1% which is a high effect. And the value of $^{2}\eta$ =0.021 means that the effect of psychological status on HADS (ANXIETY) among patients with Parkinson's disease influences 2.1% which is a small effect.

Table (6): Independent sample t-test to test the difference between patients with psychological problems and the healthy control group in the mean of HADS.

HADS	Group	N	Mean	S. D	T-test	df.	P-value	η2
DEPRESSION	The control group	20	2.25	1.83	3.378	38	.002**	.231
	PD Group	20	6.10	4.76				
ANXIETY	The control group	20	3.75	1.71	.909	38	.372	.021
	PD Group	20	4.65	4.08				

**the difference is significant at 0.01 level.

Effect size and eta squared (η2):

The results in table (6) show that the mean HADS (ANXIETY) in the healthy control group = 3.75 with standard deviation =1.71, and the mean HADS (ANXIETY) in patients with psychological problems = 4.65 with standard deviation = 4.08.

The absolute value of calculated t-test is (t-test =0.909) which is less than (t-critical = 2.02) at a degree of freedom of (38) and at 0.05 level of significance and the (p-value = 0.372 > 0.05). As a result, there is no significant difference in HADS (ANXIETY) between patients with PD and the healthy control group.

Table (7): Comparison between patients with and without anxiety/depression in terms of gender.

		Gender		P-value	Comment
		Male N=14	Female N=6		
DEPRESSION	Without depression	9	4	.919	No relationship
		45.0%	20.0%		
	Depression	5	2		
		25.0%	10.0%		
ANXIETY	Without anxiety	9	6	.091	No relationship
		45.0%	30.0%		
	Anxiety	5	0		
		25.0%	0.0%		

Table (8): Comparison between patients with and without anxiety/depression in terms of Education.

		Education				P-value	Comment
		Primary N=2	Intermediate N=3	High school N=4	University N=11		
DEPRESSION	Without depression	2	1	4	6	.166	No relationship
		10.0%	5.0%	20.0%	30.0%		
	Depression	0	2	0	5		
		0.0%	10.0%	0.0%	25.0%		
ANXIETY	Without anxiety	2	2	4	7	.412	No relationship
		10.0%	10.0%	20.0%	35.0%		
	Anxiety	0	1	0	4		
		0.0%	5.0%	0.0%	20.0%		

Table (9): Comparison between patients with and without anxiety/depression in terms of Age.

		N	Mean	S. D	T-test	df	P-value	Comment
DEPRESSION	Without depression	13	60.69	8.310	0.506	18	.619	No difference
	Depression	7	58.29	13.073				
ANXIETY	Without anxiety	15	60.60	10.280	0.574	18	.573	No difference
	Anxiety	5	57.60	9.581				

B: There is a significant difference in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) between patients with depression and patients without depression, at a significant level ($\alpha \leq 0.05$).

To test the hypothesis, we use an independent sample t-test, to test the difference between patients with depression and patients without depression.

The results in table (10) show that**:**

B-1. There is a significant difference in MMSE between patients with depression and patients without depression (p-value = 0.238 > 0.05)**.**

B-2. There is a significant difference in DIGIT SPAN (FORWARD) between patients with depression and patients without depression (p-value = 0.209 > 0.05).

B-3. There is a significant difference in DIGIT SPAN (BACKWARD) between patients with depression and patients without depression (p-value = 0.192 > 0.05).

B-4. There is a significant difference in STROOP TEST (Time) between patients with depression and patients without depression (p-value = 0.861 > 0.05) **.**

B-5. There is a significant difference in STROOP TEST (Error) between patients with depression and patients without depression (p-value = 0.658 > 0.05) **.**

B-6. There is a significant difference in TMT (A) between patients with depression and patients without depression (p-value = 0.441 > 0.05) **.**

F-7. No difference in TMT (B) between patients with depression and patients without depression (p-value = 0.115 > 0.05).

Table (10): Independent sample t-test to test the difference in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) between patients with depression and patients without depression.

			N	Mean	S. D	T-test	Df	P-value	η2
MMSE		Without depression	13	25.69	2.25	1.283	18	.238	.121
		Depression	7	23.29	4.68				
DIGIT SPAN	FORWARD	Without depression	13	4.85	0.99	1.304	18	.209	.086
		Depression	7	4.29	0.76				
	BACKWARD	Without depression	13	3.62	0.77	1.357	18	.192	.093
		Depression	7	3.14	0.69				
STROOP TEST	Time	Without depression	13	43.79	21.58	.178	18	.861	.002
		Depression	7	45.36	11.47				
	Error	Without depression	13	3.38	2.69	.450	18	.658	.011
		Depression	7	4.00	3.32				
TMT	A	Without depression	13	112.77	48.84	.789	18	.441	.033
		Depression	7	135.29	79.73				
	B	Without depression	13	204.08	80.66	1.655	18	.115	.132
		Depression	7	291.00	156.93				

7: There is a significant difference in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) between patients with anxiety and without anxiety, at a significant level ($\alpha \leq 0.05$).

To test the hypothesis, we use an independent sample t-test to test the difference between patients with anxiety and normal ones.

The results in table (11) shows that**:**

G-1. No difference in MMSE between patients with anxiety and without anxiety (p-value = 0.355 > 0.05)**.**
G-2. No difference in DIGIT SPAN (FORWARD) between patients with anxiety and without anxiety (p-value = 0.513> 0.05) **.**

G-3. There is a difference in DIGIT SPAN (BACKWARD) between patients with anxiety and without anxiety (p-value = 0.022 < 0.05) **.**

G-4. No difference in STROOP TEST (Time) between patients with anxiety and without anxiety (p-value = 0.330 > 0.05) **.**

G-5. No difference in STROOP TEST (Error) between patients with anxiety and without anxiety (p-value = 0.484 > 0.05) **.**
G-6. No difference in TMT (A) between patients with anxiety and without anxiety (p-value = 0.164 > 0.05) **.**

G-7. No difference in TMT (B) between patients with anxiety and without anxiety (p-value = 0.755 > 0.05).

Table (11): Independent sample t-test to test the difference in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) between patients with depression and the control group.

			N	Mean	S. D	T-test	df	P-value	η2
MMSE		The control group	20	28.55	1.47	2.93	25	0.02*	0.46
		Depression	7	23.29	4.68				
DIGIT SPAN	FORWARD	The control group	20	5.45	1.00	2.80	25	0.01*	0.24
		Depression	7	4.29	0.76				
	BACKWARD	The control group	20	3.85	0.88	1.93	25	0.07	0.13
		Depression	7	3.14	0.69				
OOP TES	Time	The control group	20	30.20	14.28	2.53	25	0.02*	0.20
		Depression	7	45.36	11.47				

	Error	The control group	20	1.10	1.28	2.26	25	0.06	0.31
		Depression	7	4.00	3.32				
TMT	A	The control group	20	89.40	31.96	2.18	25	0.04*	0.16
		Depression	7	135.29	79.73				
	B	The control group	20	111.45	37.13	3.00	25	0.02*	0.49
		Depression	7	291.00	156.93				

H8: There is a significant difference in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) between patients with depression and the control group, at a significant level ($\alpha \leq 0.05$). To test the hypothesis, we use an independent sample t-test to test the difference between patients with depression and the control group**.**

The results in table (12) show that**:**

H-1. There is a difference in MMSE between patients with depression and the control group (p-value = 0.02 < 0.05)**.**

H-2. There is a difference in DIGIT SPAN (FORWARD) between patients with depression and the control group (p-value = 0.01 < 0.05) **.**

H-3. No difference in DIGIT SPAN (BACKWARD) between patients with depression and the control group (p-value = 0.07 > 0.05) **.**

H-4. There is a difference in STROOP TEST (Time) between patients with depression and the control group (p-value = 0.02 < 0.05) **.**

H-5. No difference in STROOP TEST (Error) between patients with depression and the control group (p-value = 0.06 > 0.05) **.**

H-6. There is a difference in TMT (A) between patients with depression and the control group (p-value = 0.04 < 0.05) **.**

H-7. There is a difference in TMT (B) between patients with depression and the control group (p-value = 0.02 < 0.05).

Table (3): Independent sample t-test to test the difference in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) between patients with anxiety and patients without anxiety.

			N	Mean	S. D	T-test	df	P-value	η2
MMSE		Without Anxiety	15	25.27	2.91	.949	18	.355	.048
		Anxiety	5	23.60	4.72				
DIGIT SPAN	FORWARD	Without anxiety	15	4.53	0.74	.706	18	.513	.049
		Anxiety	5	5.00	1.41				
	BACKWARD	Without Anxiety	15	3.67	0.72	2.497	18	.022*	.257
		Anxiety	5	2.80	0.45				
STROOP TEST	Time	Without Anxiety	15	46.71	19.44	1.002	18	.330	.053
		Anxiety	5	37.22	13.81				
	Error	Without Anxiety	15	3.87	2.92	.714	18	.484	.028
		Anxiety	5	2.80	2.77				
TMT	A	Without Anxiety	15	109.67	49.00	1.452	18	.164	.105
		Anxiety	5	153.60	83.99				
	B	Without Anxiety	15	229.60	123.74	.317	18	.755	.006
		Anxiety	5	249.20	105.39				

*the difference is significant at 0.05 level.

9: There is a significant difference in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) between patients with anxiety and the control group, at a significant level ($\alpha \leq 0.05$).

To test the hypothesis, we use an independent sample t-test to test the difference between patients with anxiety and the control group**.**

The results in table (13) show that**:**

I-1. No difference in MMSE between patients with anxiety and the control group (p-value = 0.08 > 0.05)**.**

I-2. No difference in DIGIT SPAN (FORWARD) between patients with anxiety and the control group (p-value = 0.41> 0.05) **.**

I-3. There is a difference in DIGIT SPAN (BACKWARD) between patients with anxiety and the control group (p-value = 0.00 < 0.05) **.**

I-4. No difference in STROOP TEST (Time) between patients with anxiety and the control group (p-value = 0.33 > 0.05) **.**

I-5. No difference in STROOP TEST (Error) between patients with anxiety and the control group (p-value = 0.25 > 0.05) **.**

I-6. No difference in TMT (A) between patients with anxiety and the control group (p-value = 0.164 > 0.05) **.**

I-7. There is a difference in TMT (B) between patients with anxiety and the control group (p-value = 0.04 < 0.05).

Table (4): Independent sample t-test to test the difference in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) between patients with anxiety and the control group.

			N	Mean	S. D	T-test	df	P-value	η2
MMSE		The control group	20	28.55	1.47	2.32	23	0.08	0.43
		Anxiety	5	23.60	4.72				
DIGIT SPAN	FORWARD	The control group	20	5.45	1.00	0.83	23	0.41	0.03
		Anxiety	5	5.00	1.41				
	BACKWARD	The control group	20	3.85	0.88	3.75	23	0.00*	0.22
		Anxiety	5	2.80	0.45				
STROOP TEST	Time	The control group	20	30.20	14.28	0.99	23	0.33	0.04
		Anxiety	5	37.22	13.81				
	Error	The control group	20	1.10	1.28	1.33	23	0.25	0.16
		Anxiety	5	2.80	2.78				
TMT	A	The control group	20	89.40	31.96	1.68	23	0.16	0.26
		Anxiety	5	153.60	83.99				
	B	The control group	20	111.45	37.14	2.88	23	0.04*	0.52
		Anxiety	5	249.20	105.39				

*the difference is significant at 0.05 level.

DISCUSSION

Parkinson's disease patients displayed great psychological problems that led to having cognitive impairments. To our knowledge, this is the first study that explored the psychological effects on cognitive functions in Parkinson's disease in Saudi Arabia society. Overall, the results confirm the study's hypotheses which concluded that PD patients who have displayed psychological problems showed cognitive impairments. These results encourage the use of neuropsychological profile assessment for identifying the cognitive impairments in PD patients, such as those recently proposed by.[26] To achieve our study's aim, we used a statistical package for social science to determine the psychological status of cognitive performance among PD patients.

In this study, most of the neuropsychological assessment scales showed significant differences between PD patients with a psychological problem and PD patients without psychological problems. Regarding the independent sample t-test in the (MMSE, DIGIT SPAN forward, STROOP TEST, TMT, and HADS depression) scales, results indicated

significant differences between PD patients with psychological problems and PD patients without psychological problems. Furthermore, most independent t-test results showed significant differences between PD patients with depression/anxiety and the control group. Also, the effect of psychological status on most of the neuropsychological assessment among PD patients was high.

The observed association between patients with psychological problems and patients without psychological problems fits well with the hypothesis that there is a significant difference in the STROOP TEST between patients with psychological problems and patients without psychological problems, at a significant level ($\alpha \leq 0.05$). These results confirm some of the earlier researches that have supported the effect of psychological status on cognitive function in PD patients, which can be found in studies reporting an increase in the depression and cognitive impairments in Parkinson's disease.[27,28]

Although the effect of psychological status on most neuropsychological assessment among PD patients was high in general, some scales showed a correlation with the study's hypotheses. The effect of psychological status on Mini-Mental State Examination DIGIT SPAN (FORWARD) among patients with Parkinson's diseases showed a low effect. Also, the effect size and eta squared ($\eta 2$) showed a medium effect of psychological status on TMT (A) among patients with Parkinson's disease and a small effect of psychological status on HADS (ANXIETY) among patients with Parkinson's disease. Particularly, there was no difference shown in the (MMSE, DIGIT SPAN, STROOP TEST, and TMT) scales between PD patients with depression/anxiety and normal PD patients using independent sample t-test, which showed a correlation with the sixth and seventh hypotheses.

Several studies have shown a similar correlation where this study has fallen short.[29,30] The reasons behind this correlation are noted in a number of PD patients which suggested that some PD patients concealed or denied having depression or any other psychological problems and some PD patients might not be fully aware of having psychological problems. The reasons behind these suggestions are that some of the PD patients feel that they have become dependent on their families which made them conceal having any psychological problems.[31] but many care partners noticed the PD patients psyche affected by the disease. Also, another reason for these suggestions is that it opposes the Islamic believes of accepting having Parkinson's disease, which made some PD patients deny having psychological problems. It is

worth mentioning that the small correlation in the study might be from the fact that the study group population is limited to a specific number. This shortcoming correlation in this study leaves the door open for further investigation.

Although we used the Statistical Package for Social Science (SPSS V.26) and thoroughly explored our data, we are aware that our study method has some limitations. First, A limitation of this study is shown between PD patients with depression/anxiety and PD patients without psychological symptoms. However, even in this specific group, a significant difference was found in most of the neuropsychological assessments. Second, the studies that we used to support our findings were limited to a specific psychological problem which is depression. A further limitation of this study is that there was no performance correction made on the multiple comparisons because it would affect the integrity of the important findings found due to the adjustment of the p-value. Another limitation in the current study is the narrow size of PD patients in each group, and thus this problem likely had a limited impact on the findings of the current study. Finally, our statistics analysis did not include studies on patients with a history of other psychological problems that are not related to Parkinson's disease. However, for assessing the effect of psychological problems on cognitive function in PD patients, we adopted levels close to the neuropsychological assessment used for the traumatic brain injury study sample,[32] supporting the relative findings of our research results Nevertheless, these findings may not be consistent with previous researches, but they could be useful in future studies. In addition, future work should also consider all the above limitations.

Our results demonstrated the significance of the diagnosis of depression in PD patients, as well as the diagnosis of psychological symptoms of (depression and anxiety) and to seek to have therapeutic interventions to reduce the effects of psychological symptoms on cognitive functions. Furthermore, extensive results carried out showed that this method helps the specialists (doctors, physicians, and caregivers) in understanding the nature of Parkinson's disease and its accompanying symptoms. However, in a similar study by[29] did not find other factors such as: (disease stage and duration, disability to perform daily life activities, and sleep disturbances) which contributes to inducing depression in PD patients.

In conclusion, PD patients are at higher risk of developing cognitive impairments if they experience psychological problems. Moreover, PD patients with depression and anxiety are more likely to experience cognitive disabilities. Further, the psychological problems patients

experience due to Parkinson's disease did not correspond with the results of some neuropsychological assessments. Thus, future studies should use these findings to verify the risk of developing cognitive impairments due to psychological problems.

CONCLUSIONS

This study found that depression in PD had more impact on cognition, compared to anxiety in patients with PD in Saudi Arabia. Depression seemed to affect multiple cognitive domains, whereas anxiety affects more the abilities that rely on the frontal lobe. These findings may help clinicians and families to have a better understanding of the impact of psychological disorders in PD.

Table of Tables

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