Cognitive, sleep, and neurophysiological markers among suicidal depressed patients

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Background
Depressive disorders are associated with the highest probability of suicide. Different cognitive factors raise the probability of suicide. Sleep disorders are closely related to depression and may play a role in suicide.

Aims
Evaluation of whether suicidal depressed patients reveals distinct signs of cognitive, sleep, and neurophysiologic damage compared with depressed people who are not suicidal.

Settings and design
A case–control study involving suicidal depressed patients and non-suicidal in comparison to the control group.

Patients and methods
A random collection of 120 participants, who were divided into three groups at a ratio of 1:1:1 to be subjected to structured clinical interview for DSM-5(SCID-I), Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment scale (MoCA), Hamilton Depression Rating Scale (HDRS), Beck Scale for Suicidal Ideation (BSSI), Epworth Sleepiness Scale (ESS), and Standard Electroencephalogram (EEG).

Statistical analysis
SPSS, version 22, for analysis of data.

Results
Cognitive impairment, especially attention, language, visuospatial, naming, abstract thinking, and sleep disorders were significantly higher in suicidal depressed patients than in non-suicidal depressed patients and control. EEG shows no significant difference among the groups.

Conclusion
Suicidal depressed patients had significant impairment in different cognitive domains and sleep but no significant difference in EEG compared with non-suicidal depressed patients or control.

Keywords:
cognition, depression, sleep

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Introduction

When a person commits suicide, it is described as when they kill themselves either directly or indirectly, while intending to do so [1].

The risk of attempted and accomplished suicide is highest among those with major depressive disorder across their lifetime. Indeed, patients with MDD have a 35–40% lifetime probability of committing suicide [2].

Recognizing how and why some people's mental processes led them to commit suicide is important since several cognitive characteristics, such as cognitive stiffness, thought suppression, prospective thinking, and goal adjustment, might increase the risk of suicide [3]. The findings of trials in which behavioral tests of cognitive rigidity were administered to those who tried suicide and to controls support this [4].

Studies show a connection between sleep disturbances and suicidality following the management of depression [5].

Suicidal behavior has neurophysiologic components, according to certain studies. An effort has been made to link EEG to depression, whether it results in suicide or not [6].

Patients and methods

The study, a case–control, retrospective, and registered on ClinicalTrial.gov with the identified number (NCT04813835), and the Assiut University Medical Ethics Review Board approved the study under approval number: 17101378. It was conducted from March 2021 to December 2022 in the Psychiatry Unit of Assiut University, involving 120 participants in three groups: suicidal depressed, non-suicidal

depressed, and control. All participants were subjected to the following:

Structured clinical interview for DSM-5 (SCID-I) [7]

A semi-structured interview guide for making the major DSM-5 diagnoses.

Mini-Mental State Examination (MMSE)

It is a fundamental tool used widely clinically and in research to assess cognitive function and was introduced by Folstein *et al.* 1975. The Arabic version was used. Administration of the test takes between 5 and 10 min. It could be used as a screening tool for cognitive impairment. It involves assessments of orientation, focus, memory, language, and the capacity for simple order compliance. The maximum score is 30; the cutoff level for cognitive impairment is 24 for educated and 20 for illiterate [8].

Montreal cognitive assessment (MoCA) scale

A one-page, 30-point test, the MoCA scale is easily completed in about 10 min [9]. The test was administered individually to each participant, and the qualifying score is 25.

Hamilton rating scale for depression (HDRS)

It is a multiple-item questionnaire used to diagnose depression and determine severity. The Arabic version was used in this study. The questionnaire is designed for adults, probing mood, guilt, suicide, insomnia, agitation or retardation, anxiety, weight loss, and somatization [10].

Beck scale for suicidal ideation (BSSI)

A 19-item clinical research instrument to assess suicide. It was found to have high internal consistency and moderately high correlations with ratings of suicidal risk and self-administered measures of self-harm.

The items assess suicidal thoughts, the patient's attitude, internal barriers to an active attempt, a desire to die, the urge to try suicide, and any details of planning, as well as subjective feelings of control and/or 'courage' over a potential attempt. Scores can range from 0 to 38; there are no set thresholds for the scale, but the greater the number, the more serious the situation [11].

Epworth Sleepiness Scale (ESS)

A very brief questionnaire is used to measure a scale meant to measure daily tiredness. This was developed by Murray Johns at Epworth Hospital in Australia and is useful for detecting sleep disorders [12].

Electroencephalogram 'EEG'

It was done to all participants using the 8 channels using bipolar and referential montages with scalp electrodes implanted using the international 10-20 method to search about background activity, and presence of focal, provoked or unprovoked paroxysmal activity.

Statistical methods

All statistics was done using the Statistical Package for the Social Sciences (SPSS), version 22.

Results [Table 1]

Sociodemographic data

Sociodemographic data of enrolled participants (n = 120) showed no significant differences as regards data including sex, age group, marital status, occupation, education, residence, and socioeconomic status (P > 0.05).

Their mean age is 39.80 ± 9.48, 41.80 ± 10.54, and 42.98 ± 10.50 for the studied group, respectively. Most of the participants live in rural areas, is of low socioeconomic class, married, and not highly educated.

Mini- mental state examination (MMSE)

(1) Highly significant lower scores among the suicidal depressed group for total (P < 0.001), orientation (P < 0.001), registration (P < 0.001), attention (P < 0.01), visuospatial (P < 0.01), comprehension (P < 0.001), and recall (P < 0.001)
(2) Total, registration, comprehension, recall, and orientation scores among the non-suicidal depressed group were significantly lower than those of the control group (P < 0.001), whereas differences in attention, language, and visuospatial scores were not statistically significant (P > 0.05) for each of them.
(3) Significant lower scores among the suicidal depressed group than the non-suicidal for attention (P < 0.005) and registration (P < 0.019).

Montreal Cognitive Assessment (MoCA)

(1) Highly significant lower scores among suicidal depressed cases than control for total score (P < 0.001), orientation (P < 0.001), delayed recall (P < 0.001), attention (P < 0.001), visuospatial executive (P0.001), language (P < 0.01), naming (P < 0.01), and abstract thinking (P < 0.05).
(2) Insignificant differences were found for naming and abstract thought (P > 0.05), but there were significantly lower scores among the

Table 1 Results of HDRS, BSSI, MMSE, MoCA, and ESS among studied groups

Domains	Total depressed patients (*n*=80)	Control (*n*=40)	*P*[a]	Suicidal Depressed (*n*=40)	*P*[b]	Non-suicidal Depressed (*n*=40)	*P*[c]	*P*[d]
HDRS	22.24±3.25	1.40±0.71	<0.001***	21.23±3.39	<0.001***	23.25±2.79	<0.001***	0.003** 0.003**
	22 (17–29)	1 (0–3)		20 (17–29)		24 (17–28)		
BSSI	18.63±7.71	1.78±0.95	<0.001***	24.93±5.26	<0.001***	12.33±3.37	<0.001***	<0.001*** <0.001***
	17 (7-38)	2 (0-3)		25 (11–38)		12 (7–19)		
MMSE a. Orientation	9.09±0.93	9.58±0.55	0.003**	8.98±1.0	0.001***	9.2±0.85	0.022*	0.282 N.S
	9 (6–10)	10 (8–10)		9 (6–10)		9 (7–10)		
b. Registration	2.51±0.53	3±0	<0.001***	2.38±0.54	<0.001***	2.65±0.48	<0.001***	0.019* 0.019*
	3 (1–3)	3 (3–3)		2 (1–3)		3 (2–3)		
c. Attention	4.13±0.80	4.53±0.51	0.005**	3.88±0.79	<0.001***	4.38±0.74	0.29 N.S	0.005 0.005****
	4 (3–5)	5 (4–5)		4 (3–5)		5 (3–5)		
d. Language	4.40±0.70	4.70±0.46	0.016*	4.33±0.83	0.015*	4.48±0.55	0.053 N.S	0.334 N.S
	5 (2–5)	5 (4–5)		5 (2–5)		5 (3–5)		0.334 N.S/
e. Visuospatial	0.63±0.49	0.85±0.36	0.011*	0.58±0.50	0.006**	0.68±0.47	0.067 N.S	00.362 N.S
	1 (0–1)	1 (0–1)		1 (0–1)		1 (0–1)		0.362 N.S
f. Comprehension	2.30±0.63	2.85±0.36	<0.001***	2.35±0.62	<0.001***	2.25±0.74	<0.001*****	0.516 N.S 0.516 N.S
	2 (1–3)	3 (2–3)		2 (1–3)		2 (1–3)		
g. Recall	1.48±0.78	2.50±0.72	<0.001***	1.6±0.78	<0.001***	1.35±0.77	<0.001***	0.152 N.S 0.152 N.S
	2 (0–3)	3 (1–3)		2 (0–3)		1 (0–3)		
h. Total	24.53±2.2	28.03±0.7	<0.001***	24.08±2.3	<0.001***	24.98±2.09	<0.001****	0.068 N.S 68 N.S
	25 (18-30)	28 (26-29)		24 (18-30)		25 (21-30)		
MoCA a. Delayed recall	3.34±0.81	4.73±0.45	<0.001***	3.38±0.81	<0.001***	3.30±0.82	<0.001***	0.68 N.S
	3 (1–5)	5 (4–5)		4 (1–5)		3 (1–5)		
b. Language	2.61±0.59	2.93±0.27	0.001***	2.60±0.59	0.002**	2.63±0.49	0.001***	0.84 N.S
	3 (1–3)	3 (2–3)		3 (1–3)		3 (2–3)		
c. Attention	4.59±0.91	5.7±0.51	<0.001**	4.13±0.82	<0.001***	5.05±0.75	<0.001***	<0.001***
	5 (3–6)	6 (4–6)		4 (3–6)		5 (3–6)		
d. Naming	2.80±0.40	2.95±0.22	0.030*	2.73±0.45	0.006**	2.88±0.33	0.241 N.S	0.096 N.S
	3 (2–3)	3 (2–3)		3 (2–3)		3 (2–3)		
e. Abstract thinking	1.75±0.52	1.93±0.27	0.046*	1.73±0.45	0.043*	1.78±0.48	0.088 N.S	0.67 N.S
	2 (0–2)	2 (1–2)		2 (0–2)		2 (0–2)		
f. Visuospatial executive	3.48±1.17	4.88±0.34	<0.001***	3.45±0.99	<0.001***	3.50±1.34	<0.001***	0.85 N.S
	4 (0–5)	5 (4–5)		4 (2–5)		4 (0–5)		
g. Total	24.09±2.57	29±0.56	<0.001****	23.43±2.65	<0.001***	24.75±2.32	<0.001***	0.02*
	24 (15–30)	29 (20-30)		24 (15-27)		25 (19-30)		
ESS	12.65±5.14	4.60±2.09	<0.001***	15.10±4.87	<0.001***	10.20±4.19	<0.001***	<0.001***
	12 (1 –24)	4 (0–9)		15 (6–24)		10 (1–19)		

[a]Statistical difference between total depressed and control. [b]Statistical difference between suicidal depressed and control. [c]Statistical difference between non-suicidal depressed and control. [d]Statistical difference between suicidal depressed and non-suicidal group.

non-suicidal depressed cases than the control group for total *(P* < 0.001), orientation (*P* > 0.01), delayed recall (*P* < 0.001), language (*P* < 0.001), attention *(P* < 0.001), and visuospatial executive *(P* < 0.001).There was a significant lower score for total score (*P* < 0.05) and attention (*P* < 0.001) among the depressed cases with suicide than those without suicide, and insignificant difference for other domains (*P* > 0.05).

Epworth sleepiness scale (ESS)

(1) Highly significant higher score among each of the following groups (total depressed patients, depressed with suicide and depressed without suicide) than control (*P* < 0.001).

(2) Highly significant higher score of (ESS) among the depressed cases with suicide than those without suicide (*P* < 0.001).

EEG

(1) Insignificant statistical difference among each of the following groups (total depressed, suicidal depressed, and non-suicidal depressed patients) compared with control (*P* > 0.05) and among suicidal depressed cases compared with non-suicidal (*P* > 0.05). These results are seen in Table 1.

Correlations (Tables 2 and 3)

We found that among suicidal depressed patients and non-suicidal depressed patients there are:

Table 2 Correlation between depression, suicidal scales, cognitive function, and sleep disorders among suicidal depressed patients

Scales	HDRS	BSSI	MMSE	MoCA
BSSI				
r	0.886			
P	0.000***			
MMSE				
r	−0.416	−0.340*		
P	0.008**	0.032*		
MoCA				
r	−0.346	−0.326	0.939	
P	0.029*	0.040*	0.000***	
ESS				
r	0.486	0.467	−0.780	−0.789
P	0.001**	0.002**	0.000***	0.000***

Table 3 Correlation between depression, suicidal scales, cognitive function, and sleep disorders among non-suicidal depressed patients

Scales	HDRS	BSSI	MMSE	MoCA
BSSI				
r	0.916			
P	0.000***			
MMSE				
r	−0.345	−0.366		
P	0.029*	0.020*		
MoCA				
r	−0.399	−0.411	0.966	
P	0.011*	0.008**	0.000***	
ESS				
r	0.356	0.356	−0.977	−0.963
P	0.024*	0.024***	0.000***	0.000***

(1) Significant positive correlation between HDRS scores with BSSI score. (r = 0.886, P < 0.000; r = 0.916, P < 0.000), respectively, and with ESS score (r = 0.486 P < 0.001; r = 0.356, P < 0.05), respectively, significant negative correlation with MMSE score (r=−0.416 P< 0.01; r=−0.345, P< 0.05), respectively, and with MoCA score (r=−0.346 P < 0.05; r=−0.399, P < 0.05), respectively.
(2) Highly significant negative correlation between BSSI score with MMSE score (r=−0.340 P < 0.05; r=−0.366, P < 0.05), respectively, and with MoCA score (r=−0.326 P < 0.05; r=−0.411, P < 0.01), respectively; highly significant positive correlation with ESS score (r = 0.467, P < 0.01; r = 0.356, P < 0.05), respectively.

ESS score had very highly significant negative correlation with MMSE score (r=−0.780 P > 0.000; r=−0.977, P > 0.000), respectively, and MoCA score (r=−0.789, P < 0.000; r=−0.963, P < 0.000), respectively. These results are seen in Tables 2 and 3.

Discussion

This study analyzed 120 subjects, including 40 suicidal depressed, 40 non-suicidal, and 40 control subjects. The three groups were matched in age, sex, residence, education, and marital status but statistical difference was found in socioeconomic status (P < 0.05*)*. That is similar to the sociodemographic results of the study by Sotoudeh [13].

In this study, the mean age of suicidal depressed patients, non-suicidal patients, and control were 39.80 ± 9.48, 41.80 ± 10.54, and 42.98 ± 10.50, respectively, which is close to the mean age of another study for suicide (35.5 ± 12.1) [14].

We found the mean scores of BSSI for suicidal and non-suicidal depressed group were 24.93 ± 5.26, 12.33 ± 3.37, respectively, which is significantly higher than control (1.78 ± 0.95) (P < 0.001). By comparing suicidal and non-suicidal depressed groups, there was very highly significant difference (P < 0.001).

The same results was found in a study that assessed severity of suicidal ideation in patients with major depressive disorder also by BSSI [15]. We found that the mean total score of MMSE in non-suicidal depressed patients (24.98 ± 2.09) was lower than control (28.03 ± 0.73) with very high statistically significance (P < 0.001). This is similar to that found in the study by Hwang and colleagues (2021). [16].

In contrast to a study that recruited 75 subjects with MDD and 82 control that found no significant difference of MMSE score between them [17], this could be attributed to different levels of education.

The study revealed significant lower mean scores in domains such as orientation, registration, attention, language, visuospatial, comprehension, and recall among depressed and suicidal patients versus control. Also there was a highly significant difference for attention and registration between depressed suicidal patients versus non-suicidal patients, and this was consistent with results of this study [18]; there was no significant statistical difference in language between suicidal group and those non-suicidal.

These results are consistent with results for attention, memory, and language of another study [19]. Also there was no significant difference between the two groups in recall or working memory, which are similar to the results of these studies.

The study found that non-suicidal individuals scored lower in orientation, registration, recall, and comprehension, suggesting that these domains may be related to suicidality and may regulate suicidal urges [20].

Regarding MoCA, we found that the depressed group had a mean total score of (24.09 ± 2.57),

which is significantly lower than the mean score of control (29 ± 0.56) ($P < 0.001$).

Analysis of domains of the scale, we found significant lower mean scores for orientation, delayed recall, language, attention, visuospatial executive function and naming ($P < 0.001$, for naming $P < 0.05$).

The results for total score, language, and visuospatial executive is consistent with the results of a study which studied the results of MoCA among depressed versus healthy control [21], but this study did not found significant difference between the two groups in other domains; this may be attributed to different demographics.

The study found significant statistical variations in orientation, attention, language, delayed recall, naming, and visuospatial executive among suicidal patients, with no significant difference in abstract thinking. These findings align with a previous study on depressed patients, but may be inconsistent due to demographic differences [22].

We had found significant difference ($P < 0.05$) between total and attention scores, and no significant difference in other domains ($P < 0.05$) among suicidal depressed in comparison to non-suicidal. This is inconsistent with the results of a study which demonstrate insignificant difference between two groups but they studied only 19 suicidal attempters [23].

We found that the mean score of ESS of suicidal depressed patients (15.10 ± 4.87) was significantly higher than the control (4.60 ± 2.09) ($P < 0.001$) and also showed that a study of the mean score of ESS for non-suicidal patients (10.20 ± 4.19) with very high significance ($P < 0.001$) was in accordance with a study that identified significant statistical difference between depressed and healthy control [24].

In agreement with another study that included 60102 participants out of whom 30051 persons had previous suicidal attempts, and 30051 had no previous suicidal attempt. There were highly significant statistical differences between them in sleep disorders [25].

This study showed very highly significant statistical difference ($P < 0.001$) between suicidal and non-suicidal depressed patients. In accordance with the results of another study which examined the long-term consequences of depressive disorders in people from 18 to 65 years old, which include 1655 depressed without previous suicidal attempts and 58 with previous suicide, it found significant statistical difference between the two groups in sleep disorders [26].

There were insignificant statistical differences either between total, non-suicidal or suicidal patients versus control, or suicidal versus non-suicidal patients regarding background activity, presence of focal activity, and occurrence of provoked or unprovoked paroxysmal activity. This is consistent with a study for suicidal depressed patients versus control, it showed insignificant difference between two groups [27].

In contrast to other studies when compared with non-suicidal depressed patients, attempters and ideators displayed decreased beta activity in the frontal regions [28]. We found positive statistically significant correlation between (HDRS) with (BSSI) among total depressed patients, depressed suicidal patients, and depressed non-suicidal patients and with ESS.

This comes in accordance with a study that found positive correlation between (HDRS) and (BSS) [29] of another study (ESS) scores that correlated positively with scores on the HDRS [30].

Depression is correlated negatively with cognitive function. As we found that HDRS is correlated negatively with MMSE among total depressed patients, depressed suicidal patients, and depressed non-suicidal patients, and with MoCA. This is consistent with another study in Egypt, which found significant negative correlation between HDRS and (MMSE [31].

We found thatBSSI is negatively correlated with MMSE among total depressed patients, depressed suicidal patients, and depressed non-suicidal patients, respectively, the same with (MoCA). This is also found in a study by <CE: Pls insert author names here>[32] ESS score is highly negatively correlated with cognitive functions represented by the MMSE scale among total depressive patients, depressed suicidal patients, and depressed non-suicidal patients. This is also found in two studies that found that sleep disorder is associated with more cognitive impairment [33].

Conclusion

We found that depression had significant impact over total cognitive function, suicide increases the impact if it was present with depression. Suicide affects mainly attention, language, visuospatial domains in Mini-Mental State Examination. Suicide affects mainly naming and abstract thinking domains in Montreal cognitive assessment scale. Sleep is more affected in suicidal depressed than non-suicidal depressed. It is affected in the total depressed group than control. There was no significant difference between findings

in EEG among the depressed and control, among suicidal depressed and control, or among suicidal and non-suicidal depressed patients.

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Conflicts of interest
None declared.

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