

Cognitive Function Status among Students at Faculty of Medicine, Tanta University, Egypt

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ABSTRACT

Background: Cognitive function is vital for academic success, particularly among medical students who face substantial mental challenges.

Aim: This study aimed to explore the cognitive function status among Tanta University medical students and the risk factors for cognitive impairment.

Methodology: A cross-sectional study was conducted on 464 students by applying cluster random sample, using a structured, self-administered validated questionnaire covering sociodemographic data, dietary and sleep habits, physical activity, smartphone use, stress levels, and cognitive function which was assessed using cognitive failure questionnaire 2.0 (CFQ 2.0).

Results: More than half of the studied medical students had no cognitive impairment, 31.3% were borderline, and 10.3% exhibited cognitive impairment. Female students, those in the third and fourth academic years, and participants engaging in physical activity less than three days per week were more likely to experience cognitive decline. Significant associations were observed between cognitive impairment and insomnia, smartphone addiction, and elevated stress levels ($p < 0.001$). Moreover, a previous history of COVID-19 infection and a family history of dementia were linked to higher rates of impairment. Multivariate analysis confirmed that female sex, insufficient physical activity, insomnia, smartphone addiction, and higher levels of stress were the strongest independent predictors of poor cognitive performance.

Conclusion: Cognitive impairment is prevalent among a considerable proportion of students and it is associated with several modifiable and non-modifiable factors.

Keywords: Cognitive function, Cognitive impairment, Risk factors, Smartphone addiction, Medical students, Young adults.

INTRODUCTION

Cognition refers to the mental processes through which individuals acquire knowledge and understanding via thoughts, personal experiences, and perception. These processes include perception, memory, attention, language, learning, decision-making, playing a crucial role in everyday activities such as education, work, and relationships ⁽¹⁾.

Cognitive impairment, deficiencies or decline involves difficulties in memory, understanding, concentration, and decision-making that can affect daily living. This ranges from subjective cognitive decline (SCD) and mild cognitive impairment (MCI), where daily functioning remains unaffected, to severe forms such as dementia ⁽²⁾. The prevalence of MCI is 15.56% worldwide ⁽³⁾. While according to reports of World Health Organization in 2021, 35.6 million people were living with dementia in 2011, with numbers projected to rise to 75.6 million in 2030 and 135.5 million by 2050 ⁽⁴⁾.

Cognitive impairment has uncertain prognosis with varying conversion rates to dementia ranging from less than 5% to as high as 20% annually, and about 40-70% not developing dementia for over ten years. However, 15-20% report improved cognition within a year or two ⁽⁵⁾.

Several modifiable and non-modifiable factors influence cognitive functions. These factors include age,

sex, level of education, lifestyle choices such as alcohol and tobacco use, dietary habits, overall health, medical history, presence of depression and social engagement ^(6, 7). Also, stress, poor sleep quality, physical inactivity, and excessive smartphone use have been identified as risk factors affecting cognitive function ^(8, 9).

Cognitive health-promoting lifestyle interventions include everything from dietary changes and cognitive training programs (such as tasks that require problem-solving, memory exercises and brain training software) to physical activity routines and social interaction exercises improve mental health ⁽¹⁰⁾. Also, adequate sleep, relaxation technique improve mental health and play a role in maintaining cognitive function along with preventing the development or progression of neurodegenerative disorders ^(10, 11).

Assessing cognitive functions in medical students is crucial, as their academic and clinical responsibilities require advanced cognitive abilities. These students are exposed to multiple factors that may impair cognition. Identifying cognitive decline and its risk factors in this population is important for early intervention and maintaining optimal academic and clinical performance.

METHODS

Study design, setting and duration: The present study was a cross-sectional study. It was carried out at the

Faculty of Medicine, Tanta University, which is located in Gharbia Governorate, Egypt. The medical program consists of 5 years of education, followed by 2 years of internship "credited points program" and the faculty also offers other academic programs. The total number of students included in the "credited points program" during the academic year of 2023-2024 was 6193 students. Data was collected from the end of June 2024 to the end of November 2024.

Target population: This research targeted medical students at the Faculty of Medicine, Tanta University.

The study population: Study population were medical students at the Faculty of Medicine, Tanta University, in the credit points program from the second to the fifth academic year.

Exclusion criteria: Students from other programs, first-year students (to avoid adolescence phase "12-18" years) ⁽¹²⁾, and those with a history of head trauma, neurological disease or chronic illness.

Sample size: The sample size was calculated by Epi info program TM version 7. The confidence level set at 95%, the prevalence of cognitive impairment from a previous study was equal to 37.9 % ⁽¹³⁾. The acceptable margin of error around the prevalence was estimated to be 5%. The optimum sample size required to detect the outcome was 362. However, it was increased to 466 due to the application of cluster random sampling, and all individuals within each selected cluster were included.

Sampling technique: A cluster sample technique was applied. Tanta University medical students in each academic year are formally divided into ten practical classes (clusters), and choosing of clusters was by simple random sampling. One cluster was chosen at random from each academic year except for the first year. Each cluster ranged from 100 to 120 students. Two students at the 4th academic year declined to participate in the study due to their neurological complaints, so the total sample size taken was equals to 464 students.

Data collection tool: Data have been collected via self-administered questionnaire sheet, which included the following parts:

First part: Questions about socio demographic data (age, sex, residence & parents' education).

Second part: Questions about factors associated with cognitive impairment, including the following:

a) Questions about dietary habits: They were 12 questions adopted from 15-item Food frequency

questionnaire (FFQ) and one separate question about type of fat eaten ⁽¹⁴⁾.

Scoring of food habits: The food habits included 12 questions, their answers ranged from (1 to 3). Three questions had a reverse coding (3 to 1); question 2 (Frequency of eating red meat), question 10 (Frequency of drinking Soda/ artificially sweetened beverage), and question 11 (Frequency of eating fast food/noodles). The median score for all questions was calculated, and the score was divided into three categories; poor food habit for a median score of less than two, moderate habits with a median score equal to two and good habit for a median more than two.

b) Sleep habits: Eight questions were adopted from The Athens Insomnia Scale (AIS). A cutoff score of 6, distinguished between insomnia patients and healthy individuals ⁽¹⁵⁾.

c) Physical activity: Two questions about physical activities, the first one about frequency of doing physical activity ⁽¹⁶⁾ and the second one about manner of physical activity performed, adapted from International physical activity questionnaire (Short last 7 days self-administered format) (IPAQ SF) ⁽¹⁷⁾.

d) Smartphone addiction: Ten questions were adopted from smartphone addiction scale short version (SAS-SV) ⁽¹⁸⁾.

Scoring of smart phone addiction: The median score for all questions was calculated. It was equal to 3.5. Those students who had a median score < 3.5 were considered not addicted, those with a median score 3.5 were considered neutral, while those with a median score > 3.5 were considered addicted.

e) Stress: Seven questions were adopted from **stress subscale** of Depression, Anxiety and Stress Scale - 21 Items (DASS-21). Stress was classified into five levels: normal (0–14), mild (15–18), moderate (19–25), severe (26–33), and extremely severe (> 33) ⁽¹⁹⁾.

f) Other risk factors: It included 8 questions about other risk factors for cognitive decline including weight and height to measure BMI with the following weight categories: underweight (less than 18.5 kg/m²), healthy weight (18.5 to 24.9 kg/m²), overweight (25.0 to 29.9 kg/m²), obese ($\geq$ 30.0kg/m²) ⁽²⁰⁾. Other questions about smoking, previous history of Covid-19 infection and family history about dementia were also included.

Third part: 15 questions were adopted from The Cognitive Failures Questionnaire 2.0 (CFQ 2.0) ⁽²¹⁾.

Scoring of CFQ 2.0: The median score for all questions was calculated. It was equal to 2. Those students who had a median score of < 2 were considered not having

cognitive impairment, those with a median score 2 were considered borderline, while those with a median score > 2 were considered cognitively impaired.

➤ **Validation of questionnaire (face & content validity):** Face validity was evaluated by consulting a panel of three experts from Public Health and Community Medicine department to determine if the questions appeared appropriate and relevant to the target group, it was 100%. Content validity to assess the questionnaire clarity, relevance, and completeness. Content validity index had been calculated and it was 1.

➤ **Reliability:** Alpha Kronbuch's reliability was 0.85.

Pre-test study: Pre-test study was conducted on 36 students (10% of calculated sample size) before starting data collection with the following objectives: To test and evaluate the adequacy of the designed questionnaire, to estimate the time needed for filling the questionnaire, to determine the potential obstacles that might be met with during the execution of the study and to assess reliability.

Feedback of the pretest study:

The questionnaire revealed that the items were suitable and easy to be filled by the researcher, the time needed to fulfill each questionnaire was about 15 minutes. The pre-test cases were not included in the final analysis.

Statistical design: Statistical analysis of the study was conducted using the software of the Statistical Package for Social Sciences, SPSS Inc. Chicago, IL, USA, version 25. Qualitative data were represented as numbers and percentage while quantitative data were represented as mean and standard deviation for normally distributed variables. While, median and Interquartile range were used for not-normally distributed variables. The Chi-square test and Monte Carlo exact test were applied to test the association between categorical variables in two independent samples. Analysis of variance (ANOVA) was applied for quantitative parametric variables to analyze the difference between the means of more than two independent samples.

Kruskal-Wallis H was applied for quantitative nonparametric variables comparing the median between more than two independent samples. Spearman's correlation coefficient (weak=0-0.29, moderate= 0.3-0.49 and strong= 0.5-1) was used to investigate the association between ordinal, non-parametric data ⁽²²⁾. Ordinal regression analysis was used to identify predictors of cognitive impairment. The level of significance was

adopted at 5%, and the significance threshold (P value) was set at ≤ 0.05 .

Ethical consideration: A formal communication with the Dean of Faculty of Medicine at Tanta University to obtain official permission for conducting the study. Ethical considerations of the study were carried out according to The Research Ethics Committee at Faculty of Medicine, Tanta University, (Approval code: 36264MS549/3/24). An informed consent was obtained from each participant in the study. The purpose of the study was explained to all participants. Confidentiality of the collected data was ensured and was not used for any purpose other than scientific research. The research followed The Helsinki Declaration through its execution.

RESULTS

In this study, the mean age of the studied participants was 21.22 ± 1.319 , more than half of them were females (52.4%), and from rural areas (56.0%). The distribution across academic years was relatively balanced among the 2nd, 3rd, and 4th years of study.

Figure (1) showed that more than half of the participants (58.4%) had no cognitive impairment. Approximately one-third (31.3%) were classified as borderline, while 10.3% of them reported experiencing subjective cognitive impairment.

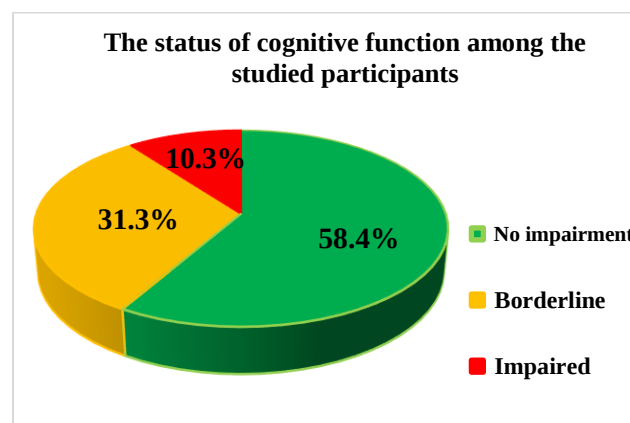


Figure (1): The status of cognitive function among studied participants.

Table (1) revealed significantly higher percentages of subjective cognitive impairment among females (15.2%) and students in their third and fourth academic years (11.2% and 12.5% respectively) ($p=0.001$). However, none of other socio-demographic factors showed a statistically significant association with cognitive function.

Table (1): The relationship between cognitive function status of the studied participants and their socio-demographic characteristics

Socio-demographic characteristics	Cognitive function status						Test of significance	p-value
	No impairment (n=271)		Borderline (n=145)		Impaired (n=48)			
	No.	%	No.	%	No.	%		
Sex								
• Male (n= 221)	143	64.7	67	30.3	11	5.0	χ^2 14.738	0.001*
• Female (n=243)	128	52.7	78	32.1	37	15.2		
Age							F	
Mean $\pm$ SD	21.21 $\pm$ 1.354		21.30 $\pm$ 1.275		21.02 $\pm$ 1.246		0.796	0.452
Residence							χ^2 2.550	0.279
• Rural (n= 260)	150	57.7	78	30.0	32	12.3		
• Urban (2=204)	121	59.3	67	32.7	16	7.8		
Study year							χ^2 22.839	0.001*
• 2 nd year (n=123)	88	71.5	23	18.7	12	9.8		
• 3 rd year (n=120)	55	45.8	51	42.5	14	11.7		
• 4 th year (n=120)	62	51.7	43	35.8	15	12.5		
• 5 th year (n=101)	66	65.3	28	27.8	7	6.9		
Nationality							MC	0.639
• Egyptian (n=433)	256	59.2	134	30.9	43	9.9		
• Palestinian (n=12)	5	41.7	4	33.3	3	25.0		
• Syrian (n=5)	3	60.0	2	40.0	0	0.0		
• Sudanese (n=14)	7	50.0	5	35.7	2	14.3		

*: Significant. χ^2 : Chi square test. MC: Monte Carlo Exact test F: One Way ANOVA.

Figure (2): revealed distinct dietary patterns across cognitive groups. Among students with no impairment, 61.7% reported good habits. The borderline group demonstrated a shift toward moderate habits (33%), while the impaired group exhibited the lowest adherence to healthy eating, with only 8.5% reporting good dietary practices and 19.2% falling into the poor category, but there was no significant association between cognitive function status and dietary habits categories (P-value= 0.182).

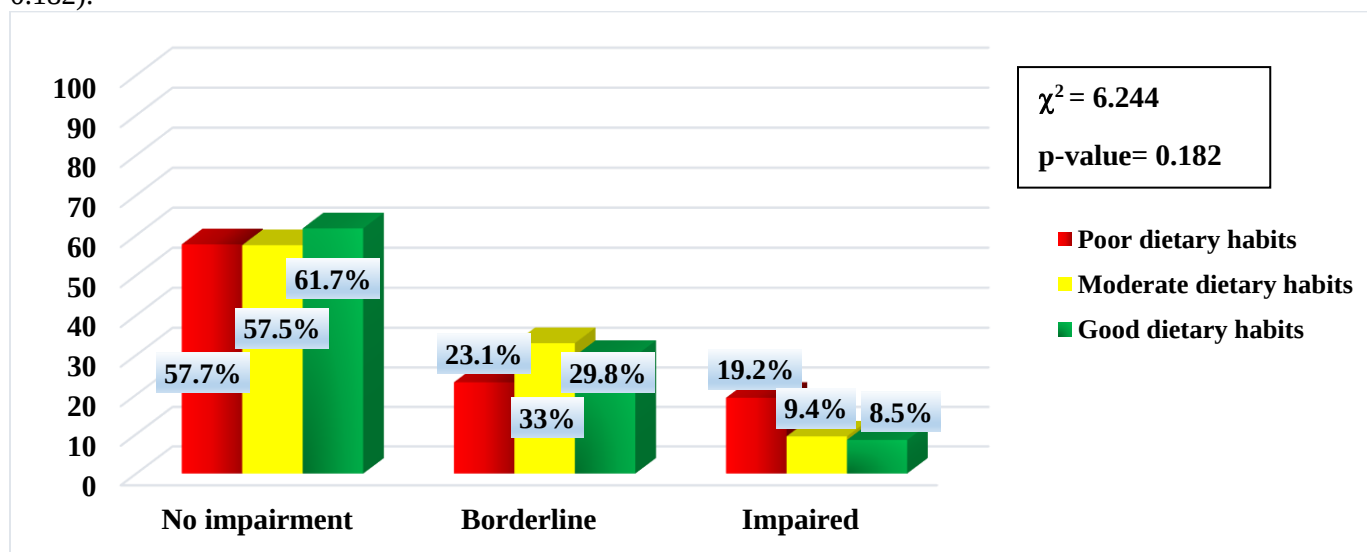


Figure (2): The relationship between cognitive function status of the studied participants and their dietary habits.

Table (2) showed significant associations between cognitive function and insomnia, smartphone addiction, and stress ($p < 0.001$). Cognitive impairment was higher among students with insomnia (17.5% vs. 3.8% without insomnia),

and among addicted students (13.3% vs. 5.5% non-addicted). Regarding stress, impairment was reported in 9.9%, 11.0% and 26.0% of those with moderate, severe and extremely severe stress, compared to 2.8% without stress.

Table (2): The relationship between cognitive function status of the studied participants and insomnia, smartphone addiction and stress

Variables	Cognitive function status						χ^2	P-value
	No impairment (n=271)		Borderline (n=145)		Impaired (n=48)			
	No.	%	No.	%	No.	%		
AIS categories:								
• Insomnia (n=223)	94	42.2	90	40.4	39	17.5	51.999	< 0.001*
• No insomnia (n=241)	177	73.4	55	22.8	9	3.8		
Smartphone addiction categories:								
• Addicted (n=249)	115	46.2	101	40.5	33	13.3	41.367	< 0.001*
• Neutral (n=32)	16	50.0	11	34.4	5	5.6		
• Not addicted (n=183)	140	76.5	33	18.0	10	5.5		
Stress categories:								
• Extreme severe (n=50)	18	36.0	19	38.0	13	26.0	63.565	<0.001*
• Severe (n=91)	40	44.0	41	45.0	10	11.0		
• Moderate (n=111)	58	52.3	42	37.8	11	9.9		
• Mild (n=67)	36	53.7	21	31.4	10	14.9		
• Normal (n= 145)	119	82.1	22	15.1	4	2.8		

*: Significant.

χ^2 : Chi square test.

AIS: Athens Insomnia Scale.

Table (3) showed that cognitive impairment was more common among students who did not engage in physical activity (38.6%) (p = 0.001), while the type of physical activity had no significant effect. BMI was also not significantly associated with cognition, yet impairment was higher in underweight (25.0%) and obese students (13.3%) compared to those with normal weight (9.5%) or overweight (9.2%).

Table (3): The relationship between cognitive function status of the studied participants and their physical activity, their body mass index and smoking status

Variables	Cognitive function status						χ^2	p-value
	No impairment (n=271)		Borderline (n=145)		Impaired (n=48)			
	No.	%	No.	%	No.	%		
Physical activity performance:							93.797	<0.001*
• No (n=70)	12	17.1	31	44.3	27	38.6		
• Yes (Less than 3 days / week) (n=233)	147	63.1	71	30.5	15	6.4		
• Yes (More than 3 days/ week) (n= 161)	112	69.6	43	26.7	6	3.7		
Kind of physical activities usually performed (n= 394):							MC	0.631
• Walk for at least 10 minutes at a time (n=230)	146	63.5	69	30.0	15	6.5		
• Moderate physical activities (n=85)	57	67.1	24	28.2	4	4.7		
• Vigorous physical activities (n=79)	56	70.9	21	26.6	2	2.5		
BMI categories:							MC	0.087
• Underweight (n=16)	11	68.8	1	6.2	4	25.0		
• Normal (n=262)	161	61.5	76	29.0	25	9.5		
• Overweight (n=141)	76	53.9	52	36.9	13	9.2		
• Obese (n=45)	23	51.1	16	35.6	6	13.3		
Smoking							MC	0.804
• No (n=454)	264	58.1	143	31.5	47	10.4		
• Yes (n=10)	7	70.0	2	20.0	1	10.0		

*: Significant

χ^2 : Chi square test

MC: Monte Carlo Exact test

Table (4) revealed significant associations between cognitive function and both a previous history of COVID-19 ($p = 0.019$) and a family history of dementia ($p = 0.001$). Cognitive impairment was more frequent among students with prior COVID-19 infection (15.6% vs. 8.7%) and those with a family history of dementia (16.1% vs. 9.5%). However, no significant associations were observed with COVID-19 illness duration, hospitalization, or degree of kinship.

Table (4): The relationship between cognitive function status of the studied participants and both history of COVID-19 and family history of dementia

Variables	Cognitive function status						Test of significance	p-value
	No impairment (271)		Borderline (145)		Impaired (48)			
	No.	(%)	No.	(%)	No.	(%)		
Previously diagnosed with COVID-19 • No (n=355) • Yes (109)	219 52	61.7 47.7	105 40	29.6 36.7	31 17	8.7 15.6	χ^2 7.943	0.019*
Duration of COVID-19 signs and symptoms • Median (IQR) • Range	7.5 (5-14) 2-30		7.0 (7-10) 3-45		8.0 (6-14) 2-21		KW 0.077	0.962
History of hospitalization because of COVID-19 • No (n=102) • Yes (n=7)	50 1	50.0 14.3	35 5	33.7 71.4	17 1	16.3 14.3	MC	0.134
Family history of dementia • No (n=402) • Yes (n=62)	249 22	61.9 35.5	115 30	28.6 48.4	38 10	9.5 16.1	χ^2 15.477	0.001*
Degree of kinship to patients with dementia • First-degree relatives (n=6) • Second-degree relatives (n=50) • Others (n=6)	1 17 4	16.7 34.0 66.6	5 24 1	83.3 48.0 16.7	0 9 1	0.0 18.0 16.7	MC	0.189

*: Significant. χ^2 : Chi square test. **MC**: Monte Carlo Exact test. **KW**: Kruskal Wallis test

Table (5) showed that females and students of the last academic years (3rd and 4th years) were significant factors of cognitive impairment. ($p= 0.033$, 0.002 & 0.001 respectively). Other predictors of cognitive impairment were the lower frequency of physical activity, positive family history of dementia, all levels of stress, insomnia and smartphone addiction [$p= 0.001$, 0.022 , (0.015 , 0.002 , 0.013 , <0.001), <0.001 and (0.028 & 0.004) respectively.]

Table (5): Multi-variate analysis of predictors of cognitive function status

Variables	Estimate	Wald	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
Sex:					
• Female	0.468	4.552	0.033*	0.038	0.898
• Male	0 ^a	-	.	.	.
Residence:					
• Rural	0.307	1.948	0.163	-0.124	0.738
• Urban	0 ^a	-	-	-	-
Study year					
• 5 th year	0.095	0.083	0.773	-0.549	0.738
• 4 th year	0.976	10.383	0.001*	0.382	1.569
• 3 rd year	0.934	9.806	0.002*	0.350	1.519
• 2 nd year	0 ^a	-	-	-	-
Frequency of physical activity:					
• Yes (More than 3 days / week)	-2.193	43.508	0.001*	-2.844	-1.541
• Yes (Less than 3 days /week)	-2.303	55.818	0.001*	-2.907	-1.699
• No	0 ^a	-	-	-	-
History of COVID-19:					
• Yes	0.438	3.144	0.076	0.046	0.921
• No	0 ^a	-	-	-	-
Family history of dementia:					
• Yes	0.685	5.282	0.022*	0.101	1.270
• No	0 ^a	-	-	-	-
Food categories:					
• Poor	-0.173	0.175	0.676	-0.985	0.639
• Moderate	-0.200	0.546	0.460	-0.731	0.331
• Good	0 ^a	-	-	-	-
Stress categories:					
• Extremely severe	1.531	15.287	<0.001*	0.763	2.298
• Severe	0.838	6.182	0.013*	0.177	1.499
• Moderate	0.991	9.472	0.002*	0.360	1.621
• Mild	0.884	5.966	0.015*	0.175	1.593
• Normal	0 ^a	-	-	-	-
AIS categories:					
• Insomnia	1.142	24.509	<0.001*	0.690	1.594
• No Insomnia	0 ^a	-	-	-	-
Smartphone addiction:					
• Addicted	0.692	8.075	0.004*	0.215	1.169
• Neutral	0.940	4.805	0.028*	0.100	1.781
• Not addicted	0 ^a	-	-	-	-

*: Significant.

0^a: Reference group.

DISCUSSION

The current study explored the cognitive function status among Tanta University medical students and the risk factors for cognitive impairment among them. It demonstrated that 10.3% of the studied participants had subjective complaints of cognitive impairment and about one third (31.3%) were classified as borderline. This may be attributed to that medical students are often exposed to high academic and psychological stress. This may heighten their self-awareness to any perceived changes in cognitive performance, making them more likely to report subjective complaints, even if the changes are minor or temporary⁽²³⁾. A study was conducted by **Taylor et al.**⁽²⁴⁾ in The United States of America showed that subjective cognitive decline (SCD) among college graduates was 7.0% that was nearly similar to the present study. While, another study conducted by **Miskowiak et al.**⁽²⁵⁾ in Denmark, highlighted that 36% of healthy control group complained of cognitive impairment. This variation in cognitive status may be due to difference in age groups, with the increase of age, the more complaints of cognitive decline will be⁽²⁵⁾.

In the current study, SCD was higher among females than males (15.2% and 5% respectively). This is in contrast to a study conducted by **Nazir et al.**⁽⁶⁾ who found that female participants had higher overall cognitive scores than males. The higher prevalence of SCD among females in the present study may reflect greater academic pressure, heightened self-awareness or a higher tendency to report cognitive concerns among female students⁽⁶⁾.

The current study demonstrated that there was a statistically significant association between smartphone addiction and cognitive function status. These results align with those of a previous study conducted by **Kancharla et al.**⁽⁹⁾ in India demonstrated that excessive use of smartphones may be prone to cognitive failures such as forgetfulness and distractibility. Excessive smartphone use has been linked to a higher risk of cognitive impairment. The similarity in findings across the mentioned studies can be attributed to several factors. Firstly, the study populations in these investigations primarily university students, particularly medical students are commonly exposed to excessive smartphone and internet use due to their reliance on digital devices for educational purposes⁽²⁶⁾. Secondly, the nature of excessive smartphone use often involves behaviors such as multitasking, reduced sleep duration, and prolonged screen exposure, all of which have been shown to negatively impact different cognitive abilities⁽⁹⁾.

The current study showed a statistically significant association between stress and cognitive function status. These results are consistent with the findings of a study conducted in 2014 in India by **Ganesh Pradhan et al.**⁽²⁷⁾ mentioned that university exams are a form of stressor, which affect cognitive function of first

year medical students. The similarity between the findings of the current study and those of previous research may be attributed to the shared focus on academic stress as a contributing factor to cognitive function impairment. Elevated stress levels were associated with decreased cognitive performance among medical students⁽²⁸⁾. The current study demonstrated that there was a statistically significant association between frequency of physical activity performed and cognitive function status. This aligns with the results of study conducted in Slovakia in 2020 among university students, which showed that physical activity is linked to better cognitive task and academic performance⁽²⁹⁾.

The present study showed that there was a statistically significant association between previous history of COVID-19 and cognitive function status. This is consistent with results of a study conducted in China in 2023 among medical students that revealed a high prevalence of mental and cognitive decline symptoms among Chinese medical students after the COVID-19 pandemic⁽³⁰⁾. The similarity between the findings of the present study and those of previous research may be explained by the growing evidence that SARS-CoV-2 infection can affect neurological and cognitive function, regardless of disease severity. This suggests that the virus may exert direct or indirect neuro-inflammatory effects causing cognitive changes, requiring further investigation and follow-up⁽³⁰⁾.

The current study showed that there was statistically significant association between family history of dementia and cognitive function status. This is consistent with results of a study conducted on medical students by **Nazir et al.**⁽⁶⁾ at Lahore Medical and Dental College linking family history to an increased risk of cognitive impairment. The similarity in findings of both studies was attributed to several factors. Firstly, both studies highlight a significant association between family history of dementia and cognitive function, which may reflect the influence of shared genetic predispositions. Numerous studies have established that individuals with a first-degree relative affected by dementia are at higher risk of cognitive decline potentially due to inherited genetic mutations or familial risk factors⁽⁴⁾.

CONCLUSION

The present study concluded that a notable proportion of the medical students at Tanta University reported subjective cognitive impairment. Key predictors of cognitive impairment included female sex, advanced academic year, low frequency of physical activity, high levels of stress, insomnia, smartphone addiction and a family history of dementia. Additionally, lifestyle behaviors such as irregular breakfast consumption and frequent intake of fast food were also linked to poorer cognitive outcomes.

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