

# Executive Function Deficits Associated with Anxiety and Depression and their Impact on Medical Students' Academic Performance in Saudi Arabia

Sulhi A. Alfakeh<sup>1\*</sup>, Alya S. Alharbi<sup>2</sup>, Mohammed K. Alhebshi<sup>2</sup>, Abdullah F. Attar<sup>2</sup>

<sup>1</sup>Faculty of Medicine, Department of Internal Medicine, King Abdulaziz University, Jeddah, Saudi Arabia.

<sup>2</sup>Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia.

\*Correspondence to: Sulhi A. Alfakeh (Email: salfakeh@kau.edu.sa)

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## Abstract

**Objectives:** This study aimed to determine the relationship between EF deficits associated with anxiety and depression and their impact on medical students' academic achievement in Saudi universities.

**Methods:** A cross-sectional online survey was conducted on 242 medical students. Anxiety and depression were assessed using the Barkley Deficits in Executive Functioning Scale (BDEFS), General Anxiety Disorder-7 scale (GAD-7), and the Patient Health Questionnaire (PHQ-9).

**Results:** Participants' mean age was 22.57 (2.26) years and the mean GAD-7, PHQ-9, and BDEFS scores were 10.54 (5.83), 12.29 (6.86), and 196.78 (47.78), respectively. Males, Saudi students, those in their fourth academic year, and those who were not satisfied with their academic performance had significantly higher mean GAD-7, PHQ-9, and BDEFS scores. A significant negative association was found between students' grade point average (GPA) and BDEFS scores, and a significant positive association was found between GPA and GAD-7 scale scores, PHQ-9 scores, and BDEFS scores. Additionally, there was a positive association between the PHQ-9 and BDEFS scores.

**Conclusion:** A real-world application of EF scales to address EF deficits for all university students should be considered.

**Keywords:** Executive function, anxiety, depression, academic performance, Saudi Arabia, students, medical

## Introduction

Executive functions (EFs) are a widespread set of neurocognitive processes that include flexible and complex goal-directed behaviors, thoughts, and emotions. In addition, they include working memory, sustained attention, inhibition, and planning (Shanmugan & Satterthwaite, 2016)<sup>1</sup> allowing for adaptation to fluctuating environmental demands.<sup>2</sup> EFs are important in many aspects, including mental and physical health, well-being, and educational and career development.<sup>3</sup> They are essential in maintaining and measuring improvements in academic performance.<sup>4</sup>

Memory, self-control and inhibition, flexibility, and planning are skills related to EFs, which are consequential for good academic performance.<sup>5</sup> The relationship between EFs and education starts in early childhood and continues to develop over the years, with a clear impact on academic achievement.<sup>1</sup>

Recently, the importance of EFs and their effect on academic performance and achievement have been observed in the development of studying methods and environments. Therefore, changes in these skills may alter academic achievement.<sup>6</sup> Furthermore, new academic environments challenge students' EFs, and a lack of self-control deteriorates study progress.<sup>6</sup> Additionally, failure in self-regulation also causes procrastination, which is defined as an intentional delay to initiate or complete a task, leading to severe difficulties for students in obtaining optimal educational outcomes.<sup>7</sup> In a study conducted in the USA, 30–60% of undergraduate students complained about postponing tasks and studying for exams, writing papers, and completing assignments.<sup>7</sup> Students with EF deficits achieve lower grade point averages (GPAs) than other students.<sup>6</sup> Students with cognitive or emotional disabilities are also at risk of academic failure.<sup>8</sup> Additionally, students with lower levels of multiple EF skills are more prone to encountering issues when planning and controlling their study progress.<sup>6</sup>

In 2015, a study was conducted in the Netherlands on 1,332 students who were in their first academic year of Applied Sciences. EFs with regard to behavioral ratings were assessed to measure its influence on academic achievement. Results indicated that students with higher EF scores at the beginning of the first academic year gained higher grades; in contrast, students with lower EF scores attained lower grades.<sup>6</sup>

Previous studies have found that medical education is a stressful and predisposing factor for anxiety.<sup>9,10</sup> In addition, studies have also stated that first-year students are more anxious than final-year students and that their level of anxiety decreases over.<sup>11,12</sup> However, the prevalence of anxiety symptoms was high even in patients with no cognitive impairment.<sup>13</sup>

A thorough literature review revealed that no study in the Kingdom of Saudi Arabia (KSA) so far has aimed to assess the associations among EF deficits, anxiety, and depression among medical students.

## Materials and Methods

The Barkley Deficits in Executive Functioning Scale (BDEFS) is used to identify areas of impairment, based on which effective student counseling can be implemented.<sup>14</sup> It helps the counselor inform students about their strengths and weaknesses and provide the ultimate guide to successful academic life. It can also provide an indication of current or future academic performance for college students.<sup>15</sup>

This cross-sectional study was conducted in 10 Saudi universities. An online survey was conducted using a self-administered questionnaire. The inclusion criteria were medical students and interns in Saudi Arabia aged 17–25 years; non-medical students were excluded.

Electronic consent was obtained from all participants. Regarding ethical considerations, ethical approval for the study was obtained from the research ethics committee of

King Abdulaziz University (KAU), Jeddah, KSA (Reference number 21–22). Participants were informed about the study idea and its aim at the beginning of the survey to obtain their consent for participation.

Students were asked about their age, gender, nationality, academic year, GPA, and satisfaction with academic performance. EFs were assessed using the BDEFS since it has the salient ability to predict impairments in social relationships, professional work, and everyday life.<sup>16</sup> The BDEFS is divided into five major categories: time management, organization and problem solving, self-inhibition, motivation, and emotion regulation. In addition, the scale provides a total score for EFs. Participants with higher scores were believed to have greater EF deficits.<sup>17–19</sup>

Anxiety was assessed using the General Anxiety Disorder-7 (GAD-7) scale, which is a valuable tool used to screen for anxiety and assess its severity in different fields.<sup>20</sup> This scale comprises seven questions regarding whether participants have been bothered by the symptoms mentioned in the questionnaire (and how often) during the past two weeks. Each symptom has four response options, scored from 0–3, where 0 represents *not at all* and 3 represents *nearly every day*. The results are interpreted according to the total score; 0–4 corresponds to minimal anxiety, 5–9 to mild anxiety, 10–14 to moderate anxiety, and 15–21 to severe anxiety.<sup>20,21</sup>

We used the Patient Health Questionnaire (PHQ-9) to assess depression; it comprises 10 questions: the first includes nine items and has four response options from 0 to 3. Consequently, a score of  $\geq 10$  in this questionnaire is considered a diagnostic cutoff point for depressive symptoms.<sup>22,23</sup>

Data were analyzed using SPSS version 25 (Armonk, NY: IBM Corp.). Qualitative data were presented as numbers and percentages. Quantitative data were presented as means and standard deviations (Mean [SD]). The Mann–Whitney U, Kruskal–Wallis, independent sample *t*-test, and ANOVA were applied to assess the relationships between variables according to data normality. Statistical significance was set at  $P < 0.05$ .

## Results

**Table 1** shows that the mean age of the participants was 22.57 (2.26) years, 57.9% were females, 88.8% had a Saudi nationality, and 57% were from the KAU university. Approximately 35% (35.5%) were sixth year students, and 28.9% were satisfied with their academic performance, with a mean GPA of 4.44 (5.89). The mean GAD-7, PHQ-9, and BDEFS scores were 10.54 (5.83), 12.29 (6.86), and 196.78 (47.78), respectively.

**Table 2** shows that male students, Saudi students, those in the fourth academic year, and those who were not satisfied with their academic performance had significantly higher mean GAD-7 scores ( $P < .05$ ). Alternatively, a non-significant relationship was found between mean GAD-7 scores and participants' university ( $P > .05$ ).

**Table 3** shows that male students, those in the fourth academic year, and those who were not satisfied with their academic performance had significantly higher mean PHQ-9 scores ( $P < .05$ ). Alternatively, a non-significant relationship was found between the mean PHQ-9 scores and participants' nationality and university ( $P > .05$ ).

**Table 4** shows that students of Taif university, those in the fourth academic year, and those who were not satisfied with their academic performance had significantly higher mean

**Table 1. Participant distribution according to their demographic details, university, academic year, satisfaction with academic performance, and mean scores of GPA, GAD-7, PHQ-9, and BDEFS (N = 242)**

Variable	No. (%)
Age (mean $\pm$ SD)	22.57 $\pm$ 2.26
Gender	
Female	140 (57.9)
Male	102 (42.1)
Nationality	
Non-Saudi	27 (11.2)
Saudi	215 (88.8)
University	
BMC	15 (6.2)
FCOMS	10 (4.1)
ISNC	29 (12)
KFU	13 (5.4)
KAU	138 (57)
KSU	10 (4.1)
KSAU	10 (4.1)
Taibah U	
TU	1 (0.4)
UQU	12 (5)
Academic year	
Second	47 (19.4)
Third	29 (12)
Fourth	31 (12.8)
Fifth	19 (7.9)
Sixth	86 (35.5)
Intern	30 (12.4)
Satisfaction with academic performance	
No	172 (71.1)
Yes	70 (28.9)
GPA	4.44 $\pm$ 5.89
GAD-7	10.54 $\pm$ 5.83
PHQ-9	12.29 $\pm$ 6.86
BDEFS	196.78 $\pm$ 47.78

BMC, Batarji Medical College; FCOMS, Fakeeh College for Medical Sciences; ISNC, Ibn Sena Medical College; KFU, King Faisal University; KAU, King Abdulaziz University; KSU, King Saud University; KSAU, King Saud Bin Abdulaziz University; Taibah U, Taibah University; TU, Taif University; UQU, Um AlQura University; GPA, Grade Point Average; GAD-7, General Anxiety Disorder-7 scale; PHQ-9, Patient Health Questionnaire; BDEFS, Barkley Deficits in Executive Functioning Scale.

BDEFS scores ( $P < .05$ ). Alternatively, a non-significant relationship was found between the mean BDEFS scores and participants' gender or age ( $P > .05$ ).

**Table 5** shows that a significant negative correlation was found between students' GPA and BDEFS scores ( $r = -.19$ ,  $P = .003$ ). **Figures 1** and **2** illustrate a highly significant positive correlation between GPA and GAD-7 scores and both PHQ-9 ( $r = .647$ ,  $P < .001$ ) and BDEFS ( $r = 0.44$ ,  $P < .001$ ) scores,

Table 2. Relationship between mean GAD-7 scores and participants' demographic details, university, academic year, and satisfaction with academic performance

Variable	GAD-7 Anxiety scale scores (Mean ± SD)	Test	P-value
Gender			
Female	8.4 ± 5.91	4.96*	<.001
Male	12.09 ± 5.27		
Nationality			
Non-Saudi	10.24 ± 5.84	2.26*	.023
Saudi	12.93 ± 5.25		
University			
BMC	12.27 ± 4.87	8**	0.0688
FCOMS	9.00 ± 4.69		
ISNC	11.07 ± 6.27		
KFU	11.85 ± 5.58		
KAU	10.22 ± 5.92		
KSU	11.40 ± 6.41		
Taibah U	–		
TU	8.83 ± 5.27		
UQU	12.40 ± 6.51		
KSAU	9.40 ± 5.68		
Academic year			
Second	11.02 ± 5.19	5**	.001
Third	10.97 ± 5.3		
Fourth	14.48 ± 5.42		
Fifth	9.37 ± 5.27		
Sixth	9.19 ± 6.44		
Intern	9.90 ± 4.42		
Satisfaction with academic performance			
Yes	8.97 ± 5.59	2.69*	.007
No	11.17 ± 5.82		

BMC, Batarji Medical College; FCOMS, Fakeeh College for Medical Sciences; ISNC, Ibn Sena Medical College; KFU, King Faisal University; KAU, King Abdulaziz University; KSU, King Saud University; KSAU, King Saud Bin Abdulaziz University; Taibah U, Taibah University; TU, Taif University; UQU, Um AlQura University; GAD-7, General Anxiety Disorder-7 scale. \*Mann-Whitney test; \*\* Kruskal-Wallis test.

Table 3. Relationship between mean PHQ-9 scores and participants' demographic details, university, academic year, and satisfaction with academic performance

Variable	PHQ-9 Depression scale scores (Mean ± SD)	Test	P-value
Gender			
Female	9.8 ± 6.83	4.86*	<.001
Male	14.11 ± 6.3		
Nationality			
Non-Saudi	12.06 ± 6.95	1.58*	.113
Saudi	14.19 ± 5.85		
University			
BMC	12.87 ± 5.3	8**	.636
FCOMS	9.20 ± 4.36		
ISNC	12.59 ± 6.25		
KFU	13.15 ± 6.76		
KAU	12.04 ± 7.28		
KSU	13.00 ± 5.53		
Taibah U	–		
TU	11.50 ± 6.81		
KSAU	16.40 ± 7.6		
UQU	112.20 ± 7.75		
Academic year			
Second	12.68 ± 6.3	5**	.002
Third	12.24 ± 5.22		
Fourth	17.26 ± 7.64		
Fifth	9.95 ± 6.22		
Sixth	11.21 ± 7		
Intern	11.20 ± 6.18		
Satisfaction with academic performance			
Yes	10.06 ± 6.93	3.16*	.002
No	13.2 ± 6.63		

BMC, Batarji Medical College; FCOMS, Fakeeh College for Medical Sciences; ISNC, Ibn Sena Medical College; KFU, King Faisal University; KAU, King Abdulaziz University; KSU, King Saud University; KSAU, King Saud Bin Abdulaziz University; Taibah U, Taibah University; TU, Taif University; UQU, Um AlQura University; GPHQ-9, Patient Health Questionnaire. \*Mann-Whitney test; \*\* Kruskal-Wallis test.

respectively. Figure 3 illustrates a highly significant positive correlation between PHQ-9 and BDEFS scores ( $r = .61, P < .001$ ).

## Discussion

EF skills are essential in achieving satisfaction in academic life; although it is an important field of study, there is a significant knowledge gap regarding the assessment of EF in a representative college sample.<sup>15</sup> Thus, our study aimed to assess the relationship between EF deficits, depression, and anxiety, and the impact of these factors on academic achievement. In the present study, male students had significantly higher mean GAD-7 anxiety scores. A recent study was conducted in 2019, with a sample size of 1,311 college students enrolled in five US

universities; the participants were 18 to 28 years of age, and two-thirds of the population was female (64.9%). The results found that males encountered significant problems on the self-inhibition and self-motivation scales.<sup>15</sup>

This study found that students in the fourth academic year had significantly higher mean PHQ-9 scores than those in other academic years. The previously mentioned US study indicated that the younger the participants, the more problems they had with self-restraint and emotion regulation.<sup>15</sup> Additionally, another study found that male students and those in higher academic years may need specific attention and interventions.<sup>24</sup>

We used the PHQ-9 to assess depression in contrast to the Beck Depression Inventory used in other studies.<sup>25</sup> We used

Table 4. Relationship between mean BDEFS scores and participants' demographic details, university, academic year, and satisfaction with academic performance

Variable	BDEFS scores (Mean ± SD)	Independent sample t-test	P-value
Gender			
Female	190.36 ± 46.02	1.79	.075
Male	201.43 ± 48.64		
Nationality			
Non-Saudi	208.25 ± 52.99	1.32	.186
Saudi	195.35 ± 47.03		
University			
BMC	183.46 ± 42.8	2.24*	<b>.016</b>
FCOMS	149.5 ± 20.7		
ISNC	203.20 ± 38.54		
KFU	200.91 ± 49.19		
KAU	206.84 ± 61.81		
KSU	178.84 ± 47.3		
Taibah U	221.5 ± 48.53		
TU	210.54 ± 54.09		
KSAU	208 ± 32.58		
UQU	199.58 ± 29.8		
Academic year			
Second	–	5.24*	<b>.001</b>
Third	176.41 ± 32.5		
Fourth	228.54 ± 57.91		
Fifth	199.26 ± 39.22		
Sixth	195.41 ± 44.73		
Intern	194.48 ± 47.51		
Satisfaction with academic performance			
Yes	192.07 ± 51.79	3.18	<b>.002</b>
No	198.45 ± 46.13		

BMC, Batarji Medical College; FCOMS, Fakeeh College for Medical Sciences; ISNC, Ibn Sena Medical College; KFU, King Faisal University; KAU, King Abdulaziz University; KSU, King Saud University; KSAU, King Saud Bin Abdulaziz University; Taibah U, Taibah University; TU, Taif University; UQU, Um AlQura University; BDEFS, Barkley Deficits in Executive Functioning Scale. \*ANOVA.

the PHQ-9 because it allows us to measure the severity of the participant's depression and assign a numerical score that can be then used to assess the relationship between depression and EF. A high prevalence of depression has been observed among medical students.<sup>26</sup> Our study supports this result. A score of  $\geq 10$  in PHQ-9 is considered significant for the diagnosis of depression; in our study, the mean scale score was found to be 12.29 for PHQ-9.

This study showed that male medical students (especially those in their fourth year) were not satisfied with their academic performance and had a significantly higher mean depression score. In contrast, some studies have denied any variation in depression scores depending on sex.<sup>27,28</sup> Alternatively, the World Health Organization states that women are more prone to depression.<sup>25</sup> Similarly, in other studies, the

Table 5. Spearman's correlation analysis among participants' age and GPA and GAD-7, PHQ-9, and BDEFS scores

Variable	Age	
	r	P-value
GAD-7	-.09	.162
PHQ-9	-.04	.457
BDEFS	.1	.11
Variable	GPA	
	r	P-value
GAD-7	.002	.97
PHQ-9	.09	.149
BDEFS	-.19	<b>.003</b>

GPA, Grade Point Average; GAD-7, General Anxiety Disorder-7 scale; PHQ-9, Patient Health Questionnaire; BDEFS, Barkley Deficits in Executive Functioning Scale.

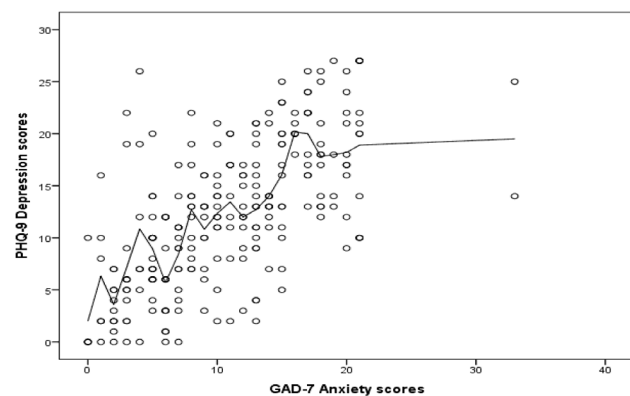


Fig. 1 Spearman's correlation analysis between GAD-7 Anxiety scores and PHQ-9 Depression scores. N.B.: ( $r = 0.647$ ,  $P$ -value =  $< 0.001$ ).

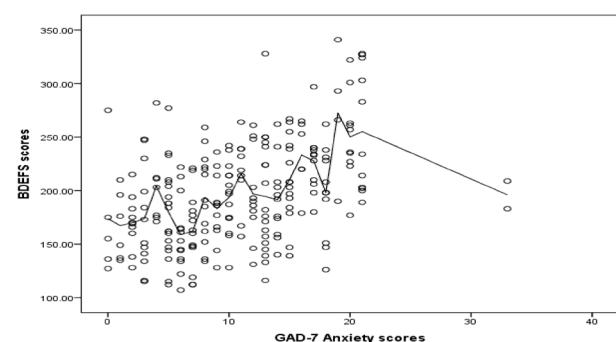


Fig. 2 Spearman's correlation analysis between GAD-7 Anxiety scores and BDEFS scale scores. N.B.: ( $r = 0.44$ ,  $P$ -value =  $< 0.001$ ).

prevalence of depression was found to be higher among female medical students.<sup>25</sup>

A study conducted in Riyadh, Saudi Arabia, showed that depression was more prevalent among first-year medical students.<sup>25</sup> This corroborates the results of the present study. Additionally, a study conducted in India showed that third year medical students reported significantly increased depressive symptoms.<sup>29</sup>

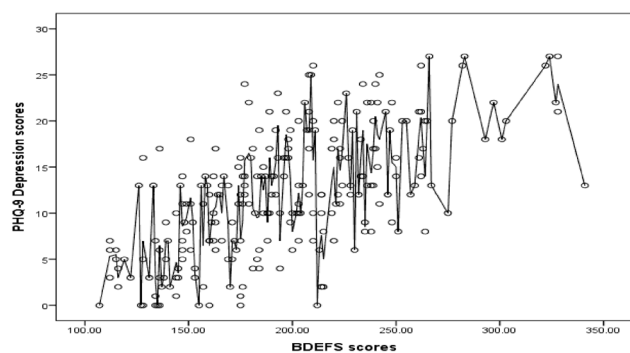


Fig. 3 Spearman's correlation analysis between PHQ-9 Depression scores and BDEFS scale scores. N.B.: ( $r = 0.61$ ,  $P$ -value =  $<0.001$ ).

This study showed that 71.1% of students were not satisfied with their academic performance, and students who were not satisfied had higher mean depression scores. Severe depression is a problem, and it is essential to diagnose depression and anxiety early to improve quality of life.<sup>30</sup>

In the present study, we used the GAD-7, which is a valid questionnaire to measure the prevalence and severity of GAD in medical students in association with EF deficits.<sup>21,31,32</sup> The prevalence of anxiety among medical students reported in 69 studies with 40,438 students was found to be 33.8%.<sup>27</sup> One study stated that the cognitive skills of people with anxiety are not different from those of the healthy general population.<sup>33</sup> Similarly, anxiety is frequently diagnosed in medical students and is found to negatively impact their academic performance.<sup>33</sup>

This study found that students in their fourth academic year were at the beginning of their clinical years and were found to have higher mean GAD-7 anxiety scale scores. Additionally, they were not satisfied with their academic performance. A similar result was found in another study that studied the importance of developing coping strategies and finding a balance between medical students' academic and personal.<sup>9</sup>

A study conducted in Singapore found that anxiety is more common in females than in males, in comparison with another study, which stated that there is no difference between the sexes.<sup>33</sup> Medical students who were not satisfied with their academic performance had a significantly higher mean GAD-7 score, higher mean PHQ-9 depression scores, and higher mean BDEFS scores. The effects of stress, anxiety, and depression on students' academic performance have also been reported in previous.<sup>26,34–36</sup>

The present study observed a non-significant relationship between mean BDEFS scores and participants' gender or age. This result does not complement that of previous studies, as age was significantly correlated with self-inhibition and emotion regulation. Additionally, younger participants reported that they had encountered more problems with inhibition.<sup>15,37,38</sup>

This variation from our results could be due to the inclusion of only medical students in our study participants.

This study found that students in the fourth academic year had significantly higher mean BDEFS scores. Alternatively, another study did not find any association between education level and EF regarding academic progress.<sup>6</sup>

Our results showed a significant negative correlation between the BDEFS scores and GPA of students. The effect of EF on study process and academic performance was also revealed in a previous study, which revealed the importance of implementing clearly targeted interventions that should be combined with student-counseling facilities and policy within universities.<sup>6</sup>

## Limitations

This study has some limitations. First, this study was conducted with a relatively small and specific population ( $n = 242$ ), and all participants were medical students. Second, other possible potentially important covariates that should be assessed in relation to academic performance were not included, for instance, childhood brain damage, learning disability, or any socioeconomic factors. Third, all medical colleges in Saudi Arabia were not involved in this study, which may have affected the generalization of the results.

## Conclusion

Male students, Saudi students, those in the fourth academic year, and those who were not satisfied with their academic performance had significantly higher mean GAD-7, PHQ-9, and BDEFS scores. A significant negative association was found between students' GPA and BDEFS scores, and a significant positive association was found between the GPA and GAD-7 scores and both PHQ-9 and BDEFS scores. Future studies including a larger sample size of Saudi medical students are recommended. In addition, a real-life application of such scales should be considered to address the EF of all university students.

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## Disclosure Statement

There are no relevant financial or non-financial competing interests to report.

## Data Availability Statement

Data supporting the results and analyses presented in the paper can be provided upon request. ■

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