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Research article

Hypertension and depression among medical students: is there an association?

Hussein Alhawari [a,*], Sameeha AlShelleh [a], Hussam Alhawari [a], Reem Akiely [a], Bayan Abdallah [a], Nada Hajjaj [a], Saja Alkhalaileh [a], Saif Aldeen AlRyalat [b]

[a] Department of Internal Medicine, School of Medicine, The University of Jordan, Amman, Jordan
[b] Department of Special Surgery, School of Medicine, The University of Jordan, Amman, Jordan

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ABSTRACT

Introduction: Several studies suggested a higher prevalence of hypertension and depression among medical students. Patients with depression have a higher prevalence of hypertension and vice versa. In this study, we assessed the frequency of hypertension and depression in a sample of medical students and the impact of depression on hypertension.

Methods: We recruited medical students from the largest medical school in Jordan. For each participant, we measured blood pressure and heart rate under standardized measurement conditions. Participants were also surveyed using the 9-item Patient Health Questionnaire (PHQ-9). We performed univariate analysis followed by linear regression analysis of factors affecting mean arterial pressure.

Results: 354 medical students were included. The mean age was 21 years. 196 (55.4%) were females and 158 (44.6%) were males. 139 (70.9%) of females had normal blood pressure (BP), 7 (3.6%) had elevated BP, 44 (22.4%) had stage 1 hypertension (HTN), and 6 (3.1%) had stage 2 HTN. Within males: 60 (38.0%) had normal BP, 27 (17.1%) had elevated BP, 55 (34.8%) had stage 1 HTN, and 16 (10.1%) had stage 2 HTN. 114 participants (32.2%) had no or minimal depression, 197 (55.6%) had mild-moderate depression and 43 (12.1%) had moderately severe-severe depression. There was an association between higher depression scores and higher diastolic blood pressure.

Conclusion: The frequency of hypertension and depression was notably high in our sample. There was an association between higher depression scores and higher diastolic blood pressure. We strongly believe that this association should encourage us again to screen our hypertensive patients in general for depression and vice versa. We also recommend adopting screening programs for depression and hypertension in general.

1. Introduction

The association between hypertension (HTN) and depression has been studied over the past decades. However, the results about the correlation between the two conditions were inconsistent, with many studies suggesting the need to consider depression as an independent risk factor for hypertension [1]. Depression is estimated to affect over 260 million people of all ages worldwide [2]. College students comprise a large percentage of the aforementioned number [3]. Moreover, it was noted that medical students in particular often show higher depression prevalence compared to students from other majors [4].

The worldwide prevalence of depression among medical students was 28% [5]. In addition, the prevalence of depression was 11% among medical students in Asian medical schools [6].

Patients with depression have a higher prevalence of hypertension and vice versa [7]. The hyperactivity of the sympathetic nervous system and genetics could explain the relationship between depression and hypertension [7]. Antidepressants may affect the control of blood pressure and could lead to orthostatic hypotension [7].

Depression might increase the risk for uncontrolled hypertension [8]. When treating depression, clinicians should also carefully assess the blood pressure status since antidepressant medications might affect the blood pressure [9].

* Corresponding author.
E-mail address: h.alhawari@ju.edu.jo (H. Alhawari).

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In this study, we assessed the frequency of hypertension and depression in a sample of medical students and we studied the possible association between depression and hypertension.

2. Methods

This study was conducted in concordance with the Declaration of Helsinki's latest report and was approved by the University of Jordan ethical committee/IRB committee. This study was conducted from June 2020 through May 2021 at Jordan University Hospital (JUH), a tertiary medical center in Amman, Jordan.

2.1. Participants

We recruited participants via announcements published in the faculty of medicine news boards and relevant social media websites. We approached medical students in their clinical years. All students who agreed to join our study had signed an informed consent form. We excluded participants who were previously diagnosed with hypertension. The initial sample size was 360 students. Six participants were excluded because they had already been diagnosed with hypertension.

2.2. Blood pressure measurement

A validated upper arm automated blood pressure device (Omron 705IT) was used for blood pressure and heart rate measurement [10]. Eligible participants were instructed not to take any caffeinated substances nor smoke or exercise for at least 30 min prior to their blood pressure measurement. Four of the Authors (B.A., N.H., R.A., and S.A.) were trained on proper blood pressure measurement such as having the participant sit and relax for at least 5 min prior to taking blood pressure readings, removing all clothing over the participant's arm, and supporting the arm and back during measurement. They measured blood pressure and heart rate for the left arm twice (1-2- minutes apart) on two different days, the two readings on each day were averaged, and then we recorded the average of the averaged two readings. The latest American Heart Association/American College of Cardiology (AHA/ACC) guidelines were used to categorize blood pressure into the groups shown in [11].

2.3. Demographic and depression questionnaire

Each participant was also asked to fill the 9-item Patient Health Questionnaire (PHQ-9) [12]. Evidence in literature supports the reliability and validity of PHQ-9 as a screening tool for depression in the general population [12, 13]. In this study, participants were categorized into three groups: group one, participants with "no or minimal depression"; group two, participants with "mild depression" and "moderate depression"; group three, participants with "moderately severe depression" and "severe depression" [14]. We also obtained data on age, gender, weight, height and household status (i.e. living with or without family).

2.4. Statistical analysis

We used SPSS version 26.0 (Chicago, USA) in our analysis. We used means (± standard deviation) to describe continuous variables. We used counts (frequencies) to describe other nominal variables. We performed univariate analysis to explain the relation between different factors and depression. Moreover, to investigate the relation between MAP and depression, we performed regression analysis.

ANOVA test was used to determine the difference in depression scores between different BMI groups, and to determine the difference in blood pressure and heart rate readings between the three depression categories. Data were assessed for normality using histograms and Q-Q plots. Assumptions for using parametric statistics were satisfactory using Levene test for equal variances. The effects of the variables: gender, household status and BMI on depression (PHQ-9) scores were determined by performing independent samples t test.

To decrease multicollinearity in regression analysis, we calculated the mean arterial pressure (MAP) for the left arm to be used as the dependent variable. Including both variables, which are highly correlated with each other, would induce multicollinearity bias. We calculated MAP as follows:

$$MAP = DP + 1/3(SP - DP).$$

We performed a linear regression analysis to analyze factors affecting MAP, where we included only variables with a significance threshold of 0.1 on univariate analysis. After that, we adopted a significance threshold for the linear regression model of 0.05.

3. Results

354 participants were included in this study with a mean age of 21.16 years (±0.9, ranging from 19 to 27). 196 (55.4%) were females and 158

Table 1. The demographic and clinical characteristics of participants.

	Gender			
	Male		Female	
	Mean	Standard Deviation	Mean	Standard Deviation
Age:	21.28	1.12	21.06	0.86
Height: (Meters)	1.76	0.07	1.63	0.06
Weight: (Kgs)	77.07	15.22	58.56	9.56
BMI:	24.70	4.60	22.03	3.29
Depression scale score "calculated":	7.63	5.20	8.05	5.15
SBP	121.91	12.77	109.32	9.89
DBP	77.34	8.84	74.75	7.41
Heart rate: (Beat/min)	77.16	12.79	83.87	11.86

BMI: Body mass index; DBP: Diastolic blood pressure; SBP: Systolic blood pressure.

Table 2. Detailed frequencies (and percent) of each BMI, Depression, and blood pressure category.

		Frequency	Percent
BMI	Underweight (BMI <18.5 kg/m^2)	33	9.3
	Normal (BMI ≥18.5 to 24.9 kg/m^2)	222	62.7
	Overweight (BMI ≥25 to 29.9 kg/m^2)	81	22.9
	moderate obesity (BMI 30 to 34.9 kg/m^2)	14	4.0
	severe obesity (BMI 35 to 39.9 kg/m^2)	2	0.6
	very severe obesity (BMI ≥40 kg/m^2)	2	0.6
	Total	*354*	*100.0*
Depression score	Minimal (Depression score 0–4)	114	32.2
	Mild-moderate (Depression score 5–14)	197	55.6
	Moderately severe-severe (Depression score 15–27)	43	12.1
	Total	*354*	*100.0*
Hypertension status-Females	Normal (<120mmHg)	139	70.9
	Elevated blood pressure (120-129mmHg)	7	3.6
	Stage 1 HTN (130-139mmHg)	44	22.4
	Stage 2 HTN (>140mmHg)	6	3.1
	Total	*196*	*100.0*
Hypertension status- Males	Normal (<120mmHg)	60	38.0
	Elevated blood pressure (120-129mmHg)	27	17.1
	Stage 1 HTN (130-139mmHg)	55	34.8
	Stage 2 HTN (>140mmHg)	16	10.1
	Total	*158*	*100.0*

(44.6%) were males. As for household status, 258 (72.9%) participants lived with their families while 96 (27.1%) participants lived alone or in students' housings. Table 1 shows the demographic and clinical characteristics of the participants. Table 2 shows the detailed frequencies and percentages of each BMI, depression, and blood pressure category in our sample.

The latest American Heart Association/American College of Cardiology (AHA/ACC) guidelines were used to categorize blood pressure into the groups shown in Table 2 [11]. In females, 139 participants (70.9%) had normal BP, 7 participants (3.6%) had elevated BP, 44 participants (22.4%) had stage 1 HTN, and only 6 participants (3.1%) had stage 2 HTN. In males, 60 participants (38.0%) had normal BP, 27 participants (17.1%) had elevated BP, 55 participants (34.8%) had stage 1 HTN, and only 16 male participants (10.1%) had stage 2 HTN.

114 participants (32.2%) had no or minimal depression, 197 (55.6%) had mild-moderate depression and 43 (12.1%) had moderately severe-severe depression as shown in Table 2. We found a statistically significant difference in diastolic blood pressure between the three depression groups ($p = 0.035$). Upon performing a post-hoc Tukey analysis, we found that the mean diastolic blood pressure difference between no-minimal and moderately severe-severe depression was 3.86 mmHg (95% CI 0.45 to 7.27, $p = 0.022$), and the mean diastolic blood pressure difference between mild-moderate and moderately severe-severe depression was 3.46 mmHg (95% CI 0.25 to 6.67, $p = 0.031$). Table 3 shows the differences in hemodynamic measurements (SBP, DBP, and HR) in different depression groups. Figure 1 shows the association between depression severity and the blood pressure.

To analyze predictors of high blood pressure, we used linear regression analysis with MAP being the dependent variable. The regression model was significant for both sides at $p < 0.001$, and an adjusted R squared of 0.205 for the left, and 0.224 for the right hand. The three variables that were found significant with the regression analysis were gender, BMI, and

Table 3. Details regarding differences in hemodynamic measurements (SBP, DBP, and HR) in different depression groups.

			N	Mean of reading	Std. Deviation	Minimum	Maximum	p-value
Systolic BP	Depression category	Minimal	114	114.96	13.69	89.00	163.00	0.738
		mild-moderate	197	114.65	12.52	86.00	161.00	
		moderately severe-severe	43	116.19	12.47	84.00	143.00	
		Total	354	114.94	12.88	84.00	163.00	
Diastolic BP	Depression category	Minimal	114	75.21	8.06	50.00	94.00	0.035*
		mild-moderate	197	75.61	7.91	57.00	102.00	
		moderately severe-severe	43	79.07	9.09	61.00	96.00	
		Total	354	75.90	8.17	50.00	102.00	
Heart Rate	Depression category	Minimal	114	80.11	13.20	54.00	111.00	0.238
		mild-moderate	197	80.66	12.35	47.00	120.00	
		moderately severe-severe	43	83.88	12.87	63.00	108.00	
		Total	354	80.88	12.71	47.00	120.00	

*P-value of 0.05 or lower was considered statistically significant.

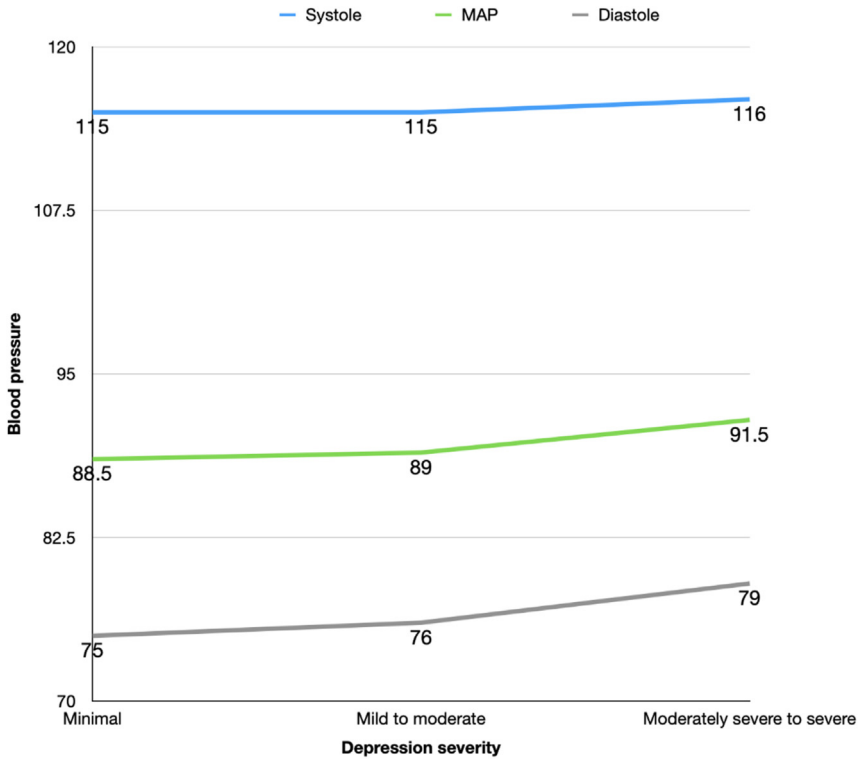

Figure 1. Systolic, diastolic, and mean arterial pressure (MAP) in each depression category, showing the association between depression severity and the blood pressure.

Table 4. Results of linear regression model analyzing factors affecting MAP.

	P value**		B coefficient		95% CI	
	Left	Right	Left	Right	Left	Right
Gender*	<0.001	<0.001	-4.291	-4.510	-6.02 to -2.56	-6.19 to -2.83
BMI*	<0.001	<0.001	0.635	0.644	0.43 to 0.84	0.44 to 0.85
Depression scale score*	0.027	0.029	0.179	0.172	0.02 to 0.34	0.02 to 0.33

*Only variables with a significant threshold of 0.1 on univariate analysis were included.
**A significance threshold of 0.05 was adopted for the linear regression model.

depression scale; being male, higher BMI and overall depression scores were associated with higher MAP as shown in (Table 4).

4. Discussion

The prevalence of hypertension and depression was notably high in our sample and we did find a statistically significant difference in diastolic blood pressure between the three depression groups ($p = 0.035$) where higher depression scores were associated with higher diastolic blood pressure. The prevalence of hypertension was also high in healthy university students in the same institution but in that study the participants were not screened for depression [15]. Only about 32% of our sample of medical students have no or minimal depression leaving about 68% of them with some elements of depression with about 12% of the whole sample having moderately severe-severe depression.

As of 2017, over 300 million people around the world have depression according to the World Health Organization [16]. The prevalence of depression was 65% among medical students in a single-center study in the country of Egypt [17]. In addition, the prevalence of depression was 45% among medical science students in another single-center study in Saudi Arabia [18].

People with major depression suffer from many cognitive symptoms that include mental stress [19]. Such mental stress is thought to alter the normal regulation of the sympathetic nervous system and the hypothalamic-pituitary-adrenal axis [20, 21] resulting in a number of downstream effects that can potentially contribute to the development of hypertension [19, 22]. It is worth mentioning as well that the link between major depression and certain behavioral factors such as increased rates of smoking and physical inactivity might also contribute to the increased risk of hypertension among depressed individuals [23]. When treating depression, clinicians should carefully assess the blood pressure status since antidepressant medications might affect the blood pressure [9].

Patients with moderate to severe depression were found to have higher systolic blood pressure, diastolic blood pressure, mean arterial pressure than patients with no or mild depression [24]. Acute psychological stressor could increase pro-inflammatory cytokines, which could lead to an increase in heart rate as well as systolic blood pressure [25]. Furthermore, the symptoms of depression could be associated with lower left ventricular ejection fraction and could be the harbinger of coronary artery diseases [25].

Participants who were found to have high blood pressure readings were advised to follow up with the primary care clinic at our university and students who showed moderately severe-severe depression were offered psychiatric evaluation at the primary care clinic as well.

Our study has some limitations with a relatively small sample size, but despite this, we found statistically and clinically significant results. We did our study during the pandemic of COVID-19, which may also explain the higher rates of depression in our sample. Longitudinal multicenter studies are needed to assess the morbidity and mortality benefits of screening hypertensive patients in general for depression and vice versa as well as screening for both conditions in general.

5. Conclusion

The frequency of hypertension and depression was notably high in our sample. There was an association between higher depression scores and higher diastolic blood pressure. We strongly believe that this association should encourage us again as providers to screen our hypertensive patients in general for depression and vice versa. We also recommend adopting screening programs for both conditions in general as both are considered major health risk factors.

Ethical considerations

This study was conducted in concordance with the Declaration of Helsinki's latest report and was approved by the University of Jordan ethical committee/IRB committee. All participants signed an informed consent.

Declarations

Author contribution statement

Hussein Alhawari: Conceived and designed the experiments; Wrote the paper.

Sameeha AlShelleh; Hussam Alhawari: Conceived and designed the experiments.

Reem Akiely; Bayan Abdallah; Nada Hajjaj; Saja Alkhalaileh: Performed the experiments.

Saif Aldeen AlRyalat: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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Data availability statement

Data will be made available on request.

Declaration of interest's statement

The authors declare no competing interests.

Additional information

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