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Stress and its correlates among medical students in six medical colleges: an attempt to understand the current situation

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Abstract

Background: Medical students encounter various stressors during their studies. The study aimed to assess stress levels, sources, and associated determinants among Sudanese medical students.

Method: An online questionnaire-based study was conducted among 617 undergraduate medical students of 6 different universities in Sudan. A 19-item questionnaire was utilized to assess stress sources, in addition to demographics, stress manifestations, and coping strategies.

Results: The overall prevalence of stress was 31.7% ($p < 0.05$). The main sources of stress were time pressure, heavy workload, fear of failure, and examination frequency. One-third of students indicated that they experienced at least one source of psychosocial- and teaching-related stress. Female medical students were more significantly stressed due to academics than males. Also, fourth- and fifth-year students were academically more stressed in comparison to the first-year students. Poisson regression analysis model showed that first-year students were less stressed than the final-year students in relation to academics (odds = 0.888, $P = 0.003$). Male medical students, across all study years, were far less stressed than females (odds = 0.901, $P = 0.000153$). Expectedly, 'studying medicine by choice' was associated with decreased odds for psychosocial stressors (odds = 0.885, $P = 0.00781$), and improved model-fit (chi-squared = 6.8952, $P = 0.008643$). Also, the year of study was a predictor of teaching-related stress development.

Conclusions: Female medical students were more stressed due to academics than males. On the other hand, final-year students were more academically stressed than first-year students. Female medical students were likely having stress related to academic stress development, while being first-year medical student was a predictor of not developing academic stress. Studying medicine by choice' was associated with ability to cope against stress.

Keywords: Stress, Medical students, Medical education, Sudan

Background

The study of medicine is perceived as being stressful and this was attributed to the breadth and the depth of the material that needs to be learned and the continuous various forms of assessments. Given the medical school curriculum's rigorous and demanding nature, increased levels of stress, anxiety, and depressive symptoms have been reported in medical students. It is estimated that the prevalence of stress among medical students is 28.5–78% [1–3]. Stress development has been shown to increase the number of adverse effects personally and professionally among medicals students. Indeed, several studies have found a strong association between high stress and

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anxiety levels and a decrease in student interactions, class performance, clinical practice, and overall poor academic performance [4, 5]. Moreover, chronic stress and anxiety were shown to be associated with mental distress, physical health problem, fear, anger, and guilt [6–9]. Unfortunately, suicide thoughts among medical undergraduates were also reported [10–12]. Other factors like dissatisfaction with the class lectures and lack of personal interest in medicine were identified as severe stress sources among medical students [3]. Previous studies have categorized sources of stress among medical students into major groups that included academia, psychosocial, and teaching and learning-related [3, 13].

Prior research has established gender and year of study as independent risk factors for stress development in medical students [2]. Notably, a high level of stress occurring in the first year of medical school can persist throughout subsequent years [14]. Also, a longitudinal study conducted in Massachusetts medical school reported a rise in the level of stress and depression in second-year medical students compared to when entering medical school [15]. In terms of gender roles, female medical students were more affected than males by stress [2, 16]. Notably, academic pressure can represent an important potential stressor [17, 18]. Therefore, it is not surprising that medical students may find coping strategies by alcohol and illicit drug intake, smoking, music, and socialization with friends [14, 18–21].

Previous studies had reported a high incidence of stress among Sudanese medical students that can range between 16 and 88.1% [1, 22]. However, information is scarce regarding the sources of stress and risk factors associated with stress development in these medical students. Hence the present study was undertaken with the following objectives: (a) to assess perceived stress levels, sources of stress, and their severity; (b) to evaluate the prevalence of the stress among male and female medical students and also among medical students in the different years of study; and (c) to assess the common manifestations of stress. This information may aid in designing appropriate intervention strategies and planning modifications in the medical curricula to enhance the students' learning abilities.

Methods

Settings and participants

This study was carried out at the faculties of medicine at six universities in Sudan. The universities were the University of Gezira, University of Khartoum, Alzaiem Alazhari University, Sudan International University, Wad Medani College of Medical Science and Technology, and College of Igra for Science and Technology between January and April 2019, comprised of males and females' students from first to the final year. These universities represent the largest universities in the capital Khartoum and central Sudan in Gezira state. Therefore, by choosing these six faculties may provide a chance to include representative participants from a wide verity of academic and cultural backgrounds, different type of medical schools in term of teaching, learning, and assessment. All these universities award the MBBS (Bachelor of Medicine and Bachelor of Surgery) degree.

Sample size

The target participants were the students from the 6 medical colleges of medicine; which was approximately 7833 for the academic year. The questionnaire was distributed randomly among students to collect the data. A self administered online questionnaire was sent to all participants. A total of 617 responses were received. The figures show that the percentage of respondents from each college is fairly proportionate to the percentage of total students in each college, thus the sample is fairly representative of each college of under study.

We calculated the required sample size for this study using the Steve Thompson equation [23], where the population size was 7833 with 99% confidence limits and an allowable error of 1%; thus final minimal sample size required was determined to be 614. However, 617 students participated in the study.

Study design and questionnaire

The questionnaires were issued at the same time in six universities to collect the data. All the students that participated were informed about the objectives of the study by the class coordinators in the six universities and those gave verbal agreement to participate were sent an online link to complete the questionnaire. The participants were assured of the confidentiality of the information provided. The ethical approval for this study was obtained from the University of Gezira, Faculty of Medicine research ethics committee. The research was conducted online; consent obtained via participants reading a script and then agreeing to participate by clicking a link to a survey after the verbal explanation of the study. Therefore, both verbal and written consent was taken from participants. The questionnaire was comprised of demographics, a 19-item list of potential stressors, manifestations (signs/symptoms) of stress, and coping strategies. Students who were not available at the time of the study were excluded.

Stressors

Psychological stress is measured by using the Kessler 10 Psychological Distress instrument (K10) developed by Kessler and colleagues to address psychological

distress [24]. It was widely used in different studies as well as the World Health organization. Most of the questions in our questionnaire were based on K10 and we have added more questions to make fit with culture and customs of Sudanese society. This was pretested in small pilot study to ensure the validity and reliability. We have used different statistical methods in order to assess the impact of academic, psychological and year of the study in stresses among medical students. The 19 sources of potential stressors were categorized as academic, psychosocial, and inadequacy in teaching-related stressors. Each response pertaining to the 19-item of potential stressors was rated according to the 3-points Likert scale (a lot = 3, some = 2, and not at all = 1). For each stress category (i.e., academic, psychosocial, and inadequacy in teaching), the median was obtained from summed up and represented graphically along with its associated interquartile range (IQR).

Data analysis

The frequency and percentage of occurrence were calculated for demographics, stressors, manifestations, and coping strategies. The median and interquartile were also calculated for the sources of potential stress. Comparison between gender, year of study, and studying medicine by choice, and the three categories of stress were carried out by one-way ANOVA and post hoc pairwise analysis test. Linear Poisson regression analysis was conducted to determine the effect of the predictors/independent variables gender, year of study, and choice of studying medicine on the development of the three categories of stress among the students. The data were analyzed using SPSS (Statistical Package for Social Sciences) version 22. *P* value of < 0.05 was considered to be statistically significant.

It is important to note that besides the pressure the medical students encounter due to academics, they also face non-academic-related sources of stress such as social, emotional, physical, and family problems that may affect their learning abilities and academic performance adversely.

Association of gender, year of study, and studying medicine by choice with the three categories of stress was examined using one-way ANOVA and post hoc pairwise comparison. We used one-way ANOVA to examine the significance of mean score differences in relation to different classes. We checked that the ANOVA assumptions conformed to our dataset. Levene's test for homogeneity of variance was not significant ($F = 0.8875$, $p = 0.471$). Normality of residuals was confirmed by visualizing the QQ-plot of the data and calculation of Kolmogorov-Smirnov test estimate ($D = 0.36179$, $p = 0.1521$.

Table 1 Distribution of demographics characteristics among the study respondents, the Sudanese medical student ($n = 617$)

Variables		Frequency	Percentage
Gender	Male	214	34.68%
	Female	403	65.32%
Year of study	First	102	16.53%
	Second	107	17.34%
	Third	93	15.07%
	Fourth	123	19.93%
	Fifth (final)	192	31.11%
Studying medicine by choice	Yes	523	84.8%
	No	94	15.2%

Ethical approval

Ethical approval was obtained from the Faculty of Medicine, University of Gezira, Sudan.

Results

Demographics of the participants

The total number of medical students who participated in the current study was 617, of whom 403 (65.32%) were females and 214 (34.68%) were males. The overall prevalence of stress was 31.7% ($p < 0.01$). The rest of the demographic features can be seen in Table 1.

Sources of stressors

The most frequently occurring sources of academic stress were time pressure (60.12%), heavy workload (58.50%), fear of failure (52.02%), and exam frequency (44.57%). The high parental expectation was the highest-scoring psychosocial stressor (33.22%). Also, inadequate or poor support by teachers ranked the highest as a source of stress for the medical students (33.06) (Table 2).

Gender effect

The mean academic stress level scores were significantly higher in females (10.4) than males (9.3, $t = 4.092$, $P = 0.00005133$; Fig, 1A). For psychosocial stress, the mean level scores were similar between females (5.6) and males (5.7, $t = 0.371$, $P = 0.7111$; Fig. 1B). Also, inadequacy in teaching relates stress mean score mean did not differ between female (3.3) and male students (3.4, $t = 0.588$, $P = 0.5569$, Fig. 1C). Overall, the results indicate that only academic stress was significantly higher in female than male medical students.

Class effect

Students of the first-year were the least stressed students (9.13), followed by second-year (9.82), third-year (mean = 10.01), then the final-year (10.28). Fourth-year students' mean academic stress score was the highest

Table 2 Frequency and percentage of the students' responses to the 19 sources of stress categorized as either academic, psychosocial, or inadequacy in teaching

Stress source	High (%)	Some (%)	Not at all (%)
Academic factors			
Exam frequency	275 (44.57%)	250 (40.51%)	92 (14.91%)
Fear of failure	321 (52.02%)	207 (33.54%)	89 (14.42%)
High self-expectation	219 (35.49%)	284 (46.02%)	114(18.47%)
Competition with peers	145 (23.50%)	258 (41.81%)	214 (34.68%)
Tight schedule	216 (35.00%)	296 (47.97%)	105 (17.01%)
Heavy workload	361 (58.50%)	196 (31.76%)	60 (9.72%)
Time pressure	371 (60.12%)	183 (29.65%)	63 (10.21%)
Attendance	231 (37.43%)	196 (31.76%)	190 (30.79%)
Psychosocial factors			
Poor motivation	192 (31.11%)	267 (43.27%)	158 (25.60%)
Financial problems	53 (8.58%)	184 (29.82%)	380 (61.58%)
Family problems	69 (11.18%)	154 (24.59%)	394 (63.85%)
Lack of family support	72 (11.66%)	139 (22.52%)	406 (65.80%)
High parental expectation	205 (33.22%)	231 (37.43%)	181 (29.33%)
Relationship with opposite sex	82 (13.29%)	164 (26.58%)	371 (60.12%)
Study away from home	153 (24.79%)	158 (25.60%)	306 (49.59%)
Loneliness	164 (26.58%)	185 (29.98%)	268 (43.43%)
Teaching-related factors			
Poor teaching skills	183 (29.65%)	306 (49.59%)	128 (20.74%)
Poor teacher support	204 (33.06%)	301 (48.78%)	112 (18.15%)
Difficulty understanding lectures	183 (29.65%)	298 (48.29%)	136 (22.04%)

Table 2 show academic, psychosocial, and teaching-related factors have a lot, some, or no effect on medical students. Only effects of high level of stress-related symptoms were included in chronological order. For instance, factors associated with academic section that scored high were time pressure (60.3%), heavy workload (58.7%), and fear of failure 52.2%). Importantly, psychosocial and teaching-related factors were all scored less than 34%

(10.41) (Fig. 2A). The mean overall stress score for academic stress among the participating students was 9.997 (standard deviation (SD) = 2.96, ranging between 0 and 16. However, only the mean academic stress scores for the fourth and final year of study students were significantly higher than first-year students' mean scores ($P = 0.0136742$, $P = 0.0104599$, respectively, Fig. 2A). The mean overall stress score for psychosocial stress among the participating students was 5.629 (SD = 3.17, ranging between 0 and 16). Psychosocial stress mean scores were similar between the students of different years/levels of study (Fig. 2B). The mean overall stress score for teaching-related stress among the participating students was 3.325 (SD = 1.70, ranging between 0 and 6). For inadequacy in teaching-related stress mean score, first-year and third-year students were the least stressed classes (both 3.00), followed by the fourth-year (3.34) and then final-year students (mean = 3.44) (Fig. 2C). Second-year students were the most stressed-out class (3.69, Fig. 2C). The overall levels of stress were not substantially different between classes ($F = 2.008$, $p = 0.0919$). However, on the pairwise post hoc comparison, fourth-year students reported significantly higher levels of academic stress than first-year students (mean difference = 1.29, $p = 0.010$). Similarly, second-year students endured more teaching-related stress compared to first-year class (mean difference = 0.69, $p = 0.027$) and third class (mean difference = 0.692, $p = 0.033$). The mean score for academic stress according to class was lowest in the first year (mean = 9.13) followed by the second year (mean = 9.82), then the third year (mean = 10.01) followed by the final year (mean = 10.28), with fourth-year students being the most stressed (mean = 10.42). These academic stress differences between classes were statistically significant ($F = 3.347$, $p = 0.0101$). The differences between classes, however, in terms of psychosocial stressors were not significant ($F = 0.773$, $p = 0.543$); the mean psychosocial stress score was highest among second-year students (mean = 6.11), followed by the final year (mean = 5.57), then the fourth-year (mean = 5.54), and third-year (mean = 5.46). The least psychosocially stressed were the first-year students (mean = 5.50). Regarding teaching-related stress, the least stressed was first and third class (mean = 3.00 for both), followed by fourth-year (mean = 3.34), final year (mean = 3.44), and second-year (mean = 3.69). The teaching-related stress differences

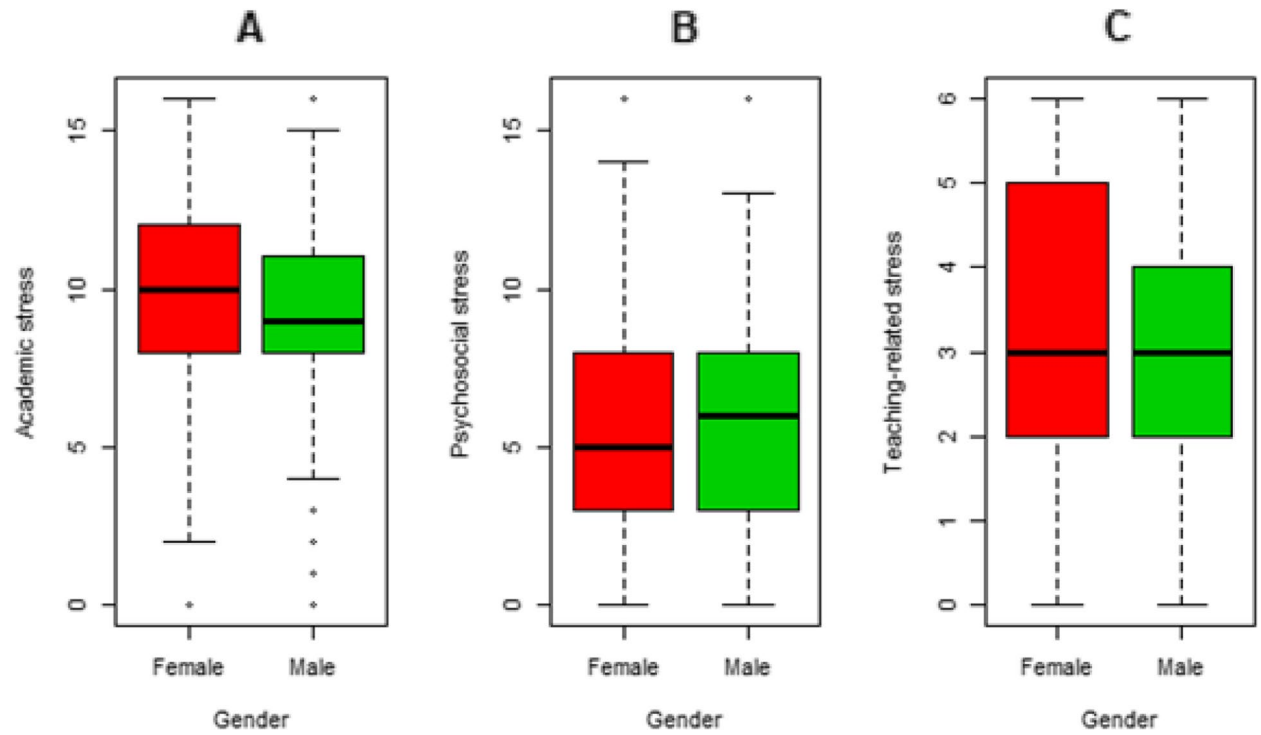

Fig. 1 Academic, psychosocial, and teaching-related stressors broken up by student gender. The box-and-whisker plots represent the stress scores (**A** Academic, **B** Psychosocial, **C** Teaching-related) broken-up by student gender. Note that the borders of the box represent the interquartile range and the whisker terminals represent the maximum and minimum score. The median score is represented by the thick black line in the middle of the box. Female students were more academically stressed than males

were significant ($F=3.267$, $p=0.0115$). The mean score for academic stress among those who were not pushed to take medicine was 9.94, only marginally lower than the mean score in those not taking medicine by choice (mean = 10.3, $t=1.1522$, $p=0.2513$). However, the mean psychosocial stress among those taking medicine by choice was significantly lower than those who were not (respective means were 5.52 and 6.23, $t=2.0451$, $p=0.04286$). Similarly, mean teaching-related stress scores were lower in those who chose to study medicine than those who did not (means = 3.27 and 3.64 respectively, $t=2.1048$, $p=0.03711$).

Overall, academic stress was significantly high in fourth- and final-year students. While stress due to inadequacy in teaching was significantly increased in second-year students; on the other hand, psychosocial stress was not significantly different between the various years of study.

Impact of medicine as choice (not pushed to study medicine)

Mean academic stress scores did not differ significantly between students who opted to study medicine by choice and those pressured into studying medicine ($t=1.1522$, $P=0.2513$, Fig. 3A). On the other hand, mean scores of psychosocial stress and inadequate teaching causing stress were significantly elevated in students that did not study medicine by choice, in comparison to those students that chose to study medicine ($t=2.1048$, p value = 0.03711; $t=1.1522$, p value = 0.2513, respectively; Fig. 3B, C). Hence, students who embarked on studying medicine by choice were significantly less affected by psychosocial and inadequacy in teaching, causing stresses than their forced-in counterparts.

Linear Poisson regression model

The effects of year of study, gender, and the choice of studying medicine on stress development using the generalized linear Poisson regression model (Table 3). In terms of academic stress, first-year students were far less stressed than the final-year students (odds = 0.888, $P=0.003$). Regardless of gender, first-year students were less stressed than final year students by 11.13%. Inclusion of gender to the model improved the model fit substantially (chi-squared = 14.504, $P=0.0001399$), which is indicative of the significant contribution of gender on the development of academic stress. Males, across all years/levels of study, were far less stressed than females

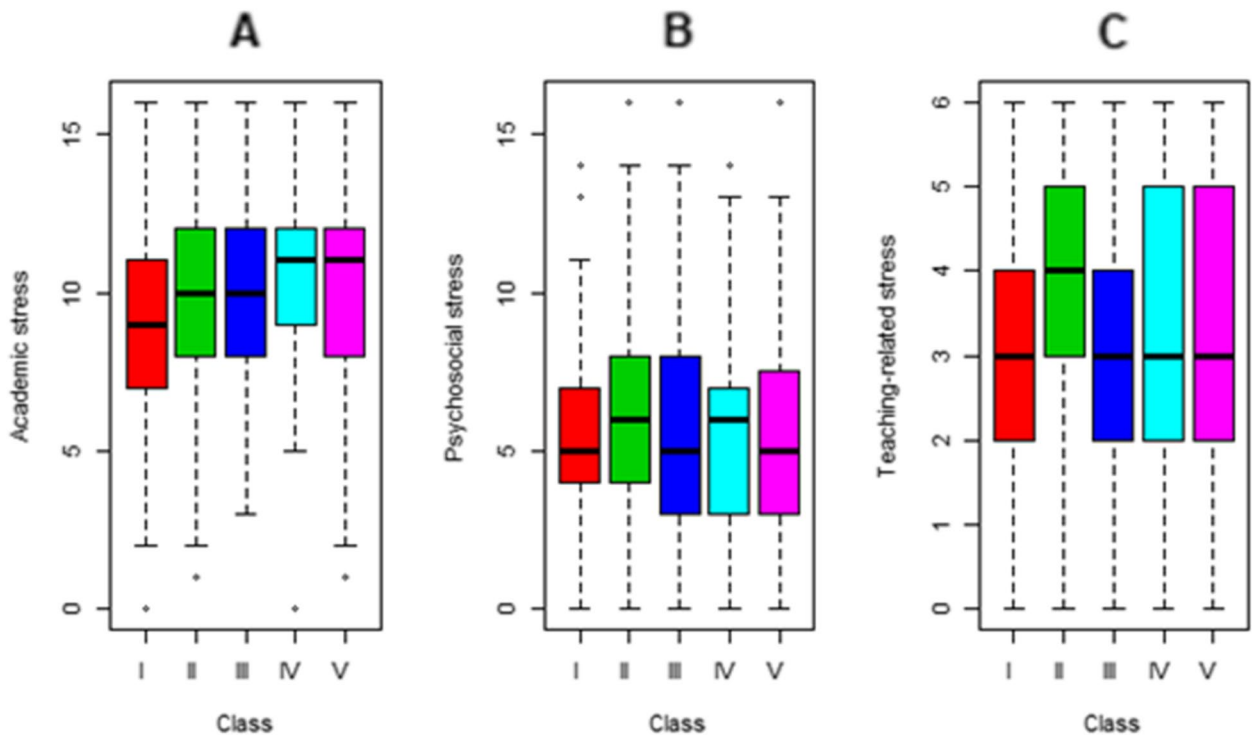

Fig. 2 Academic, psychosocial, and teaching-related stressors broken up by student class. The box-and-whisker plots represent the stress scores (**A** Academic, **B** Psychosocial, **C** Teaching-related) broken-up by student current class. Note that the borders of the box represent the first and third quartiles (width indicates the interquartile range) and the whisker terminals represent the maximum and minimum score. The median score is represented by the thick black line in the middle of the box. Final year students were more academically stressed than first year students. Also, second year students reported higher teaching-related stress than other classes. Note that in the text it mentions "for inadequacy in teaching-related stress mean score, first-year and third-year students were the least stressed classes (both 3.00), followed by the fourth-year (3.34) and then final-year students (mean = 3.44) (Fig. 2C)". However, on **C** above, all classes score was 3

(odds = 0.901, $P = 0.000153$). Also, male students' academic stress scores were less by 9.88% than their female colleagues. Notably, the effect of studying medicine by choice on the development of academic stress was not significant (odds = 0.974, $P = 0.453508$). Additionally, inclusion of its term in the model did not result in significant model-fit improvement (chi-squared = 0.55859, $P = 0.4548$) (data not shown). Hence, the year of study and gender affected the development of academic stress. This was apparent as first-year students were less stressed than upper years. Similarly, males were less affected by academic stress than female medical students.

The year of the study did not significantly influence the development of psychosocial stress in medical students. Also, inclusion of the gender in the model did not improve the model-fit measures (chi-squared = 0.1509, $P = 0.6977$). However, when we included an interaction term between the level of study and gender (i.e., adjusting for gender's effect in each year of study simultaneously), the model-fit measures improved substantially (chi-squared = 11.6, $P = 0.02059$). This analysis showed that males in the fourth year were substantially more stressed psychosocially than final year females by 34.1% on average (odds = 1.340925, $P = 0.00529$). Interestingly, 'studying medicine by choice' was associated with a decrease in the odds of developing psychosocial stress by the students) (odds = 0.885, $P = 0.00781$), and improved the model-fit measures (chi-squared = 6.8952, $P = 0.008643$) (data not shown).

Generally, year of study and gender did not affect psychosocial stress development except for fourth-year male students. Also, studying medicine by choice decreased the likelihood of developing psychosocial stress.

Regarding the effects of year of study, gender, and choice of medicine on the development of stress due to inadequacy of teaching, first-year students were 12.7% less stressed than final year students (odds = 0.873, $P = 0.0498$). The inclusion of gender effect to the model did not improve the model-fit (chi-squared = 0.31621, $P = 0.5739$), indicating that both genders were equal in terms of stress perception due to inadequacy of teaching). Also, inclusion of a 'the choice of studying of medicine'

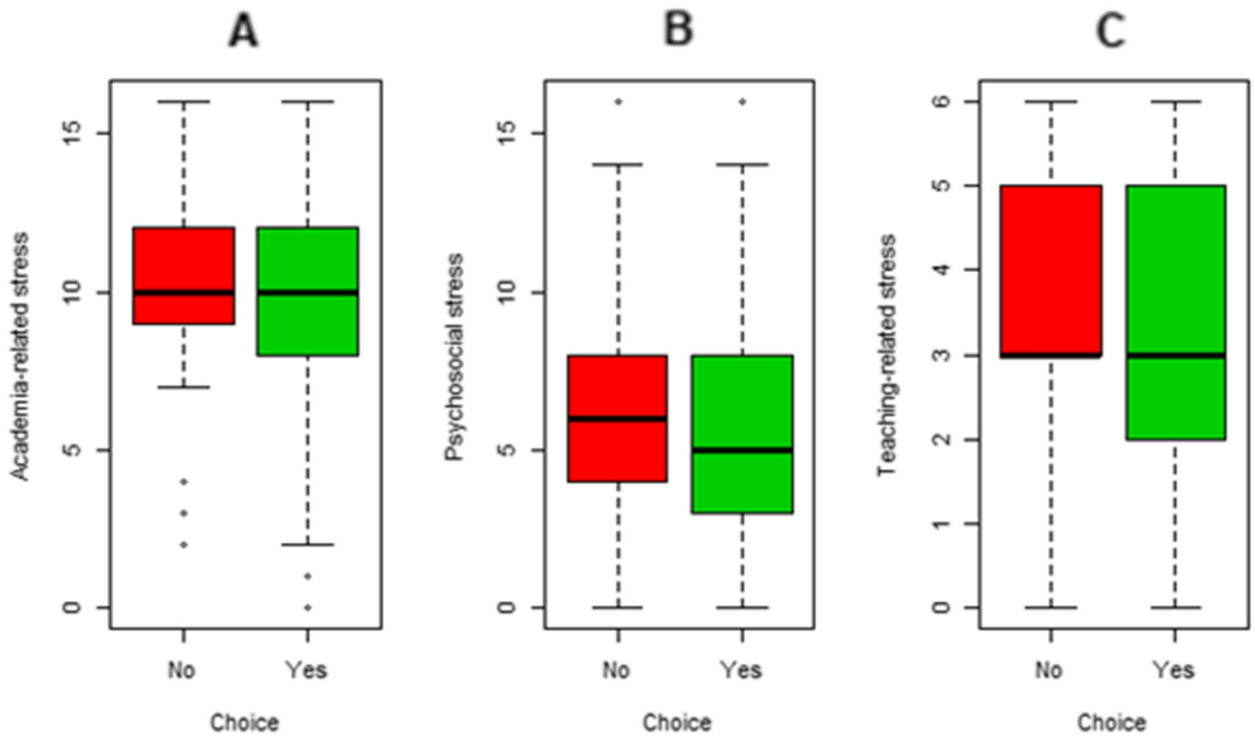

Fig. 3 Academic, psychosocial, and teaching-related stressors broken up by student choice of medical career. The box-and-whisker plots represent the stress scores (**A** Academic, **B** Psychosocial, **C** Teaching-related) broken-up by student choice of medical career. Note that the borders of the box represent the first and third quartiles (width indicates the interquartile range) and the whisker terminals represent the maximum and minimum score. The median score is represented by the thick black line in the middle of the box. Students that did not choose to study medicine were more stressed than males in terms of psychosocial stress domain

Table 3 The effect of gender, choices and class using generalized linear Poisson regression model

Symptom	Count (%)	Gender effect		Class effect		Choice effect	
		Chi	*P*	Chi	*P*	Chi	*P*
Sleep disturbance	227 (36.9%)	0.46445	0.4956	8.7095	0.06878	0.94942	0.3299
GI upset	407 (66.2%)	7.7484	0.005376	14.924	0.004861	15.662	0.00008
Appetite change	374 (60.8%)	23.576	0.0000012	3.8623	0.425	0.70752	0.4003
Worrying	273 (44.4%)	4.8785	0.02719	8.5999	0.07192	2.3338	0.1266
Forgetfulness	405 (65.9%)	2.7221	0.09897	1.6408	0.8014	1.6408	0.8014
Avoidance	399 (64.9%)	4.7763	0.02885	5.812	0.2136	4.9584	0.02596
Low confidence	352 (57.2%)	2.1641	0.1413	7.9162	0.0947	0.94935	0.3299
Agitation	463 (75.3%)	11.345	0.0007564	63.255	0.0000001	1.8726	0.1712
Indecisiveness	370 (60.2%)	6.1741	0.01296	13.396	0.009493	0.05808	0.8096
Headache	295 (48%)	5.9088	0.01507	10.264	0.0362	0.01748	0.8948
Abnormal behavior (e.g., nail biting)	451 (73.3%)	3.8965	0.04839	2.2873	0.6831	1.2621	0.2613
Anergia	315 (51.2%)	0.16592	0.6838	11.855	0.01846	0.35200	0.553

(odds = 0.910, $P = 0.1139$) in the model did not improve the model fit (chi-squared = 2.4484, $P = 0.1176$). To sum up, the year of the study did influence the development of inadequacy of teaching-related stress. In contrast, gender and choice of studying medicine did not affect this category of stress development.

Table 4 Frequency and percentage of the manifestations of stress among Sudanese medical students

Sign/symptom	Frequency	Percentage
Headache	295	48.00%
GI upset	407	66.2%
Low confidence	352	57.2%
Sleep disturbance	227	36.9%
Appetite change	374	60.8%
Worrying	273	44.4%
Forgetfulness	405	34.2%
Avoidance	399	64.9%
Indecisiveness	370	60.2%
Agitation	463	75.3%
Anergia	315	51.2%
Abnormal behavior (e.g., nail biting)	451	73.3%

Table 5 Frequency and percentage of coping strategies during stress

Coping strategy	Frequency	Percentage
Smoking	45	7.3%
Alcohol consumption	6	1%
Drug use	18	2.9%
No coping strategy use	552	91.1%

Manifestations of stress among the participants

Regarding manifestation of stress, 36.9% ($n=227$) of medical students reported sleep disturbance, while 44.4% ($n=273$) reported "worrying". 75.3% ($n=463$) and 73.3% ($n=451$) of the students reported 'agitation" and abnormal behavior (e.g., nail biting) respectively as a symptom or sign of stress (Table 4).

Coping strategies

The majority of the students reported not having enough time for personal hobbies and recreational activities (73.3%, $n=451$). Despite the high stress levels among medical students, most did not report substance abuse ($n=560$, 91.1%). Cigarette smoking was disclosed by 7.3% of participants ($n=45$), drug use was reported by 2.9% ($n=18$) of participants and 1.0% ($n=6$) of study subjects reported drinking alcohol (Table 5).

Discussion

Our current study was set out to investigate stress levels, sources, and associated predictors among Sudanese medical students. The prevalence of stress in the current study was 31.7%. Based on previous studies stress prevalence among medical students ranges from 30 to 50% [9, 13, 14, 19]. This level of stress is high in comparison to that of the general population [23] and that of students in other courses of study [13, 25]. This prevalence was similar to other British study (31.2%) [23] And lower than other studies conducted in Malaysia (41.9%), Egypt (43.7%) and Pakistani medical school (80.5%). In terms of stress prevalence, a substantial proportion of medical students (~2/3 of participants) reported at least one source of academic stress. The chief sources of academic stress were: time pressure (60%), heavy workload (58.7%), fear of failure (52.2%), and exam frequency (44.7%). Similarly, a cross-sectional survey study carried out among first and second-year female medical students showed that the most common stress source included academia [26]. Final year medical students exposed to a problem-based learning curriculum in South Africa reported academia to be the primary source of stress [27]. Additionally, an Ethiopian study that enrolled in first to sixth-year medical students reported that academic-related domain was the main source of stress [28].

In terms of the other stress categories prevalence, about a third of the medical students reported at least one form of psychosocial and teaching-related stressors. For example, 33.22% of medical students reported psychosocial stress due to high parental expectations. Importantly, the high parental expectation was reported among the most frequent (66% of respondents) and severe forms of stress in first and second medical students in Pakistan [26].

For teaching-related stress, 33.06% of medical students reported 'a lot of' stress due to poor teacher support. Knowledge and skill competencies required from medical students have become more complex and diverse. Hence, the stress burden continues to grow among medical students. Similarly, Melaku et al. showed that 29.7% of medical students had high stress, while 9.4% had severe stress due to teaching- and learning-related stressors [28]. Overall, stress in moderation helps motivate students to exert effort in knowledge and skill acquisition [29]. However, extreme stress can cripple students' ability to learn and impede the whole education process [30, 31]. The increased stress level among our sample population, especially academic stress, could place them at an increased risk of ill-health and academic underperformance [32, 33].

Importantly, we found that academic stress was significantly higher in females than males ($p<0.01$). Furthermore, through Poisson regression analysis, the female gender was a predictor of academic stress development. Similar observation was also noted in female medical students in USA, and this was attributed to the extra domestic and parental responsibilities compared to males [34]. In another study, exam stress was more frequent in

female medical students that attended the two final years of medical school than males [16]. Furthermore, the difference in this study may be due to the fact of female medical students are more competitive, tend to be more concerned about working hard to secure higher marks in exams, more concerned about their performance, exaggerate their sadness and tend to engage in less exercise. As women progress through life's stage, hormonal balance can affect chemical vulnerability to stress.

We also showed that academic stress was significantly higher in fourth- and fifth-year medical students compared to the first-year medical students. Different studies showed that the increase in clinical loads in the final years in the medical schools is associated with an increase in stress levels [34, 35]. However, other studies showed that stress can decrease with an increase in the year of studying medicine [28]. The increase in levels of stress in Sudanese medical schools in final years can be attributed to (i) the medical schools in Sudan put a lot of emphasis in high quality of training of medical students; (ii) the difference in curriculums used in Sudan in comparison with other studies; (iii) the study design or variation diagnostic instrument used to diagnose degree of stress presentations; and (iv) medical students in Sudan are aware in graduation; they need to pass international medical examinations, and this per se may also add more pressure.

In terms of psychosocial stress, medical students who chose to study medicine were significantly less stressed than students who studied medicine by choice. Also, choosing medicine was a determinant of psychosocial stress. The findings were not surprising as it is expected that students that were pressured into studying medicine will experience more stress.

For teaching-related stress, second-year medical students were more significantly stressed than first- and third-year students. This can be attributed to the fact that the increase in curriculum load and intensity of exposure to clinical and community work. Also, medical students who did not choose to study medicine were significantly more stressed due to teaching-related stressor than students that chose to study medicine. However, the choice of medicine was not a predictor for the development of teaching-related stress. The main stress manifestations among medical students were agitation (75.3%) and abnormal behavior (73.3%). Headache, GI upset, worrying, appetite change, forgetfulness, and others were reported with different percentage. Therefore, it is important to detect stresses among students earlier in order to prevent deleterious long term effects of stress on the students.

The majority of medical students did not report a specific coping strategy (91.1%), while 7.3% mentioned smoking as a coping strategy. Comparably, 9.5% of medical students in an Ethiopian cross-sectional study indicated smoking as a coping strategy [28]. Given that most medical students did not report a specific coping strategy, medical schools must introduce positive intervention coping strategies to prevent or reduce the potential negative consequences of stress.

Limitations

The current study has the strengths of large sample size, the inclusion of both genders, and the representation of its participating students since conducted in multiple universities. However, it has some limitations. Since a self-administered questionnaire was utilized, we cannot rule out response bias. Also, the study's cross-sectional design did not allow us to examine the cause and effect relationship between various stress domains and factors such as gender and year of study. In addition, not all colleges have the same curriculum (traditional, problem-based, community-based, and mixed between community- and problem-based. Therefore, a prospective study can be utilized for future studies to study such a relation.

Conclusions

A substantial proportion of Sudanese medical students had academic-related stress. Sources of such stress were time pressure, high workload, and exam frequency. Furthermore, female gender was a predictor for the development of academic stress. On the other hand, first year level of study was not a predictor of academic stress development. Also, students did not study medicine by choice experienced high psychosocial stress. Therefore, it is recommended to lessen the academic workload and frequency of assessments and rely more on active teaching and learning activities. Also, the provision of counseling and academic support by the university is essential. Students should be introduced to positive stress coping strategies. Such interventions should be applied with a particular focus on female and upper (clinical) year Sudanese medical students.

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Authors' contributions

EAR, MAD, WNO, EM, and MHS conceived the idea of this study. EAR and MAD collected the data. MA, MEA, and MHA analyzed the data. EAR, MAD, MEA, and MHA wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of this review article.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Approved by University of Gezira, Faculty of Medicine, Sudan. All procedures were conducted following the ethical guidelines. After explaining the objectives of the study and confirming confidentiality, informed verbal consent was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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