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Socioeconomic disparities and their effect on medical student academic attainment Sudanese Universities

Mohammed Hammad Jaber[1], Ibrahim Abusufian Dafallah[1*], Ayat Yousif Mohammed[2], Reel Eltahir Eltahir[3], Mohammed Awad Mohamed[4], Tarteel Abdalla Mohamed[5], Moayad Hussein Mudawi[6], Duha Osman Tayfour[7], Sana Esmail Mastor Mohammed Ali[8], Eman Mohammed Ali Mohammed Ahmed[9], Asma Mohammedelbagir Osman[9], Hala Abdallah Kakoum[10], Mawada Mohammed Bagadi[10] and Ahmed Osman Mohammed[11]

Abstract

Background Socioeconomic status (SES) is a social classification factor that takes into account income, parental education and occupation. SES has been shown to play an important role in shaping students' academic performance, including in medical schools, but there still remains significant variation in findings around SES and academic achievement worldwide. We aim to assess and explore socioeconomic disparities and their effects on medical school performance at Sudanese public and private universities.

Objectives The objective of our study was to assess the effects of age, sex, living conditions, parental education and income level on the academic achievement of medical students from universities in Sudan.

Methods This cross-sectional study was conducted among undergraduate medical students at ten public universities in Sudan between September and December 2023. Participants were included if they were older than 18 years and were studying in their 2nd year or older. The data were collected using an online questionnaire with open- and closed-ended questions measuring age, living conditions, parental income level and education. A convenience sampling method was used to recruit participants from universities. The data were analyzed using SPSS v28.0.0, and a p value less than 0.05 was used to indicate statistical significance.

Results We received 832 responses, 516 (62%) from females and 307 (36.9%) from males. The median age was 23 years. Most students lived with their families (61.1%), followed by student housing (28.2%). This study revealed age ($p = .024$) (95% CI: 0.025- 0.023) andhigh family income ($p = .019$) (95% CI: 0.018- 0.02) are associated with academic achievement in the long term, as demonstrated through cumulative grade point average (cGPA).

Conclusion The findings underscore the importance of targeted support systems to bridge the socioeconomic gaps that exist among medical students, allowing all students to thrive academically regardless of their background.

Clinical trial number None.

*Correspondence:
Ibrahim Abusufian Dafallah
ibrahimabusufian9@gmail.com

Full list of author information is available at the end of the article

Background

Socioeconomic status (SES) is a social science concept that refers to an individual's status derived from their living and working conditions and greatly influences various aspects of life, such as education and health. Individuals with low SES are widely believed to have low academic achievement [1].

A low SES can affect academic achievement through intertwined factors such as access to education, study resources, and parents' education and support. The underrepresentation of individuals from low socioeconomic backgrounds in medical school applications is well documented [2]. This disparity was attributed to various factors. A study showed that parents with low SES usually do not expect their children to attend college, coupled with pressure to prioritize family responsibilities or employment. The financial burden of attending medical school and maintaining work-life balance were identified as potential barriers for individuals with low SES [3]. Students from low SES backgrounds also face greater stress and a lesser ability to cope with medical studies, affecting their ability to perform in medical school [4, 5]. Research has shown that students from low SES backgrounds are more likely to focus on patient-centered care and rural community service than their high SES counterparts are [6]. Students with a low SES also exhibit noticeable improvement from entrance exams to national licensing exams, becoming progressively indifferent to their high SES counterparts in terms of academic achievement [7]. A study conducted in France found no link between SES and medical students' academic achievement in examining preparation for or performance on national residency exams [2]. Other studies have emphasized the role of non-socioeconomic factors such as direct education and preparation as leading factors for academic achievement rather than socioeconomic factors [8].

Medical students of higher SES are reported to usually live with their parents and have better relationships with their parents including higher levels of support from their parents, enabling greater academic achievement (9, 10). These students of high SES were noted to have a higher level of education among fathers, were motivated and influenced by their parental education status, and were students within the median age group at the faculty [11]. Despite efforts to increase the acceptance of students from low-SES backgrounds, the prevalence of high SES candidates in medical undergraduate education continues to increase [12].

To explore these disparities in academic achievement, Pokropek et al. proposed a model comprising socioeconomic indices, such as the education level and occupational status of parents, family wealth, and cultural and educational possessions [13].

Sudan, located in Northeast Africa, shares borders with the Central African Republic, Chad, Eritrea, Ethiopia, Egypt, South Sudan, and Libya. It has a population of approximately 46 million people and one of the highest crude birth rates globally, with 33.6 live births per 1,000 [14]. In April 2023, a conflict erupted between the Sudanese Armed Forces (SAF) and the Rapid Support Forces (RSF) in Khartoum resulting in the widespread displacement of over 3 million people. Another wave of displacement occurred in December 2023 when the war expanded to include Gezira State and in July 2024 to Sinnar State leading to the displacement of 7.3 million people by June 2024. In total, 12 from 18 states in Sudan are currently experiencing conflict and humanitarian crises [15, 16].

The war has significantly impacted the living conditions of families and individuals. Homes were stolen and destroyed, and the prices of living essentials have doubled since the onset of the conflict. Electricity servicing was halted in conflict-affected areas, and federal financing for water development was discontinued. Nationwide, schools were closed, with an estimated 10% of these repurposed as emergency shelters. Due to defective supply chains, most areas in the country suffer acute shortages of essential medicines and challenges in storing medications [17].

There still remains significant variation in findings around SES and academic achievement worldwide. For this reason, we undertook this study to assess the effects of age, sex, living conditions, parental education and income level on academic achievement in Sudanese universities. This study also aimed to explore the association between SES and the academic attainment of medical students from different public institutions.

Methods

Study design and settings

This cross-sectional study was conducted among undergraduate medical students at private and public universities in Sudan between September 2023 and December 2023. We conducted this cross-sectional study following the STROBE statement for reporting cross-sectional studies [18].

Participants

The study's inclusion criteria included undergraduate medical students at the faculty of medicine in Sudanese universities who were older than 18 years and who were studying in their 2nd year or above. Conversely, students

who declined participation, did not provide consent, failed to complete the data survey comprehensively, or were absent from online student groups during the study period were excluded from the research.

Sample size calculation

The sample size for this study was calculated via the following equation: n=z2 P(1-P)/d2 with a 95% confidence interval (CI), 50% response distribution and 0.05 margin of error [19]. The total population was unknown, therefore a sample of 384 participants was considered the minimum sample needed to represent the population.

Instruments

We used a questionnaire to measure the variables of interest in the study. The dependent variables included age, living conditions, parental income and education, while the independent variables were the grade point average (GPA) and cumulative grade point average (cGPA). The data were collected by investigators who agreed to share the survey. The questionnaire was divided into three main sections. The first section included demographic information (age, sex, academic year, university), the second section covered SES (living conditions and family income, father's and mother's level of education, impact of parents' level of education on their educational attitude), the last section covered academic achievement (secondary school certificate score, previous semester GPA, continuous GPA, worst degree in previous exams, whether participants ever scored F 'Fail' or was denied from taking an exam).The questionnaire was based on criteria of previously published studies [11, 20]. Data were collected from undergraduate medical students using a questionnaire that was distributed online via Google Forms. For the purposes of this study, self-reported latest GPA and cGPA were used as indicators of academic achievement. For universities that adopted the traditional grading system, the GPA was calculated from their grades as follows: A=4, B=4- 3.5, C=3.4-3, D=2.9–2.5, E=2.4-2, F<2. Monthly income was graded according to local currency into four categories: 1) very low with income less than 50,000 Sudanese Pounds (SDGs), low: 50,000–99,000 SDGs, moderate: 100,000- 130,000 and high: over 130,000 SDGs,

The official exchange rate during the study duration was 1 US\$ = 602 Sudanese Pounds.

Data collection and sampling

A convenience sampling method was used to acquire the responses from the participants via online distribution of the survey during the study period. We recruited medical students from different universities by employing targeted communication messaging on social media channels and students forums. Investigators sent an online questionnaire to the online groups of different universities using social media platforms. Weekly, the investigators reminded undergraduate medical students in their online groups during the study period to participate to ensure broader participation in the study among undergraduate medical students.

Statistical analysis

We analyzed and reported the data using the Statistical Package for Social Sciences (SPSS) v28.0.0. Continuous data were analyzed for descriptive statistics, including the mean±SD, median and interquartile range. Categorical data are presented as numbers (percentages). We used the chi-square test to determine whether there was a significant difference between the groups for categorical data. We used the Kolmogorov–Smirnov test to check the normality of the data. The Kruskal–Wallis test was used to test for a significant difference between academic grade and age. In the case of a significant difference, pairwise comparisons were performed using the median test. The results were adjusted by Bonferroni correction for multiple tests. A *p* value less than 0.05 was considered to indicate statistical significance.

Results

Study participants

We received 832 responses from medical students at Sudanese universities. The median age was 23 years, and the interquartile range (IQR) was 3 years. The Kolmogorov–Smirnov test for normality was rejected due to outlying values, which were deemed natural. 62% of the participants were females, and 51.8% of participants were aged between 21 and 23 years. 31.7% of the participants had high family incomes; the majority of the respondents(61.1%) lived with their families. (Table 1).

Students' academic performance

Most of the participants (40.6%) scored more than 90% in the Secondary School Examinations. A score between 3 and 3.4 was the most common GPA achieved during the last semester of undergraduate education, which is similar to the most commonly achieved score for cGPA. The worst score achieved by most participants in the previous exam was C. In contrast, 70.8% had never scored F before. Moreover, 82.7% of the participants had never been denied entering an exam (Table 2).

Parenteral involvement in the educational process

A majority of the students' fathers attended university (62.1%), some completed secondary school (26.2%), and a minority had primary level education (11.7%). Almost half of the mothers attended university (49.2%). According to our sample, 34.7% of mothers attended secondary school, and 16.1% attended till primary school. A total of

Table 1 Shows participant demographic and socioeconomic characteristics (*n* = 832)

Variables		Frequency	Percent %
Sex			
	Female	516	62.0
	Male	307	36.9
	Prefer not to tell	9	1.1
Age			
	16–20	114	13.7
	21–23	431	51.8
	Above 23	287	34.5
Living condition during study:			
	Family	508	61.1
	Student housing	235	28.2
	With relative	89	10.7
Academic Year			
	3rd	282	33.9
	4th	230	27.6
	5th	239	28.7
	6th	81	9.7
Family monthly income			
	Moderate	350	42.1
	Very Low	84	10.1
	Low	134	16.1
	High	264	31.7

39.9% of the students reported that their parents' education status affects their views toward studies, influencing and motivating them to achieve academically and complete university education. Almost all the students reported that their parents supported them emotionally and socially in their learning. (95.1%) (Table 3).

Factors associated with GPA

After assessing the factors that influenced the GPA of the last semester, participants who agreed that their parents' level of education affects their educational attitude, mothers' level of education, family income, living conditions and age were the most influential factors (Table 4), (Table 5).

Our study showed that income level is significantly associated with cGPA (*p* = .019) (95% Cl: 0.018- 0.02). Participants who agreed that their parents' level of education affects their educational attitude, higher level of mothers' education and fathers' education were influential factors but not statistically significant (Table 6), (Table 7).

The Kruskal−Wallis test of age against cGPA showed a significant difference (*p* = .024) (95% Cl: 0.025–0.023), degrees of freedom = 4. Pairwise comparisons using the median test showed a significant difference between cGPA 2.4–2.9 and 3.5-4 after Bonferroni correction. (*p* value = 0.046) (Fig. 1).

Discussion

The study included 832 medical students from Sudanese universities. The majority of participants were female (62%). Slightly over half of the participants were aged between 21 and 23 years and approximately one-third had high family incomes, and most of them lived with their families.

In terms of academic performance, a significant portion of participants scored more than 90% on the secondary school examinations. The most common GPA achieved in the last semester of undergraduate education was between 3 and 3.4, which aligns with the most commonly achieved score for cGPA. Most participants had never received an F grade before and had never been denied entry into an exam.

Regarding parental involvement in the educational process, a majority of the students' fathers attended university (62.1%), while almost half of the mothers attended university (49.2%). The educational status of parents had a perceived influence on participants' attitudes toward studies, although it did not have a statistically significant impact. However, almost all participants reported that their parents supported their learning. Factors such as parents' level of education affecting educational attitude, mother's level of education, family income, living conditions, and age were found to influence the participants' GPA in the last semester. However, only family income and age were found to have a significant impact on cGPA.

Table 2 Students' academic performance and challenges faced during studies. (*n* = 832)

Variables		Frequency	Percent %
Secondary school Examination			
	80 − 85%	189	22.7
	86 − 90%	231	27.8
	Less than 80%	74	8.9
	More than 90%	338	40.6
GPA Last semester			
	2–2.4	37	4.4
	2.5–2.9	202	24.3
	3–3.4	301	36.2
	3.5–4	275	33.1
	4	1	0.1
	Below 2	16	1.9
Cumulative GPA			
	2–2.4	43	5.2
	2.5–2.9	205	24.6
	3–3.4	356	42.8
	3.5–4	216	26.0
	Below 2	12	1.4
The worst grade in previous exams:			
	A	45	5.4
	B	252	30.3
	C	315	37.9
	D	93	11.2
	F	127	15.3
Did you ever Score F?			
	No	589	70.8
	Yes	243	29.2
Denied from entering an exam:			
	No	688	82.7
	Yes	144	17.3

This study showed that students from low-income backgrounds are more likely to face educational disadvantages and that their family income is likely to have a significant impact on their cGPA (*p* = .019). In Sudan, many students from low SES backgrounds and less favorable social support balance academic responsibilities with the need to work and support their families. This burden often leads to reduced study time, decreased school participation, deteriorating relationships with peers and teachers, freezing semesters, or even early university dropout. Our study findings align with a previous study that found that students with higher socioeconomic status (SES) perform better than those from with middle or lower SES [21]. In this mentioned study, SES was determined using a scale developed by Rajbir Singh et al., which considers various factors including family income [22].

The social causation model, which attributes academic achievement to social and economic factors, particularly income, parental education and occupation, aligns with these findings [23]. Economic hardships negatively affect parental attitudes and relationships, which influence student performance. Students from lower income classes often have fewer study resources and educational advantages and therefore perform worse academically. Parents of higher SES invest financial and social resources that support the cognitive and non-cognitive development of students throughout the educational journey [23]. In Sudan parents with higher SES can afford private schooling of their children with more resources and where public education is limited in capacity and resources, usually only admitted students scoring over 85% in Sudanese Secondary Examination. Additionally, higher SES parents can support their children through extra tuition, unpaid internships, training workshops, and conferences, similar to many countries in the region.

Research by Caro et al. revealed age to be a significant contributor to academic achievement. Our analysis revealed that age was significantly associated with cGPA (*p* = .024). The reasons for this are not well understood. Students in the median age group between 21 and 23 years performed better than the remaining students; however, this difference in performance was not significant [15, 24].

Table 3 Shows the parental level of education, effect of parental level of education on participants educational attitudes, and the parents' support during the learning process (*n* = 832)

Variables		Frequency	Percent
Father's level of education			
	Primary school	97	11.7
	Secondary school	218	26.2
	University	517	62.1
Mother's level of education			
	Primary school	134	16.1
	Secondary school	289	34.7
	University	409	49.2
Parent's level of education affecting participants' educational attitude			
	No	500	60.1
	Yes	332	39.9
Parents' support during learning process:			
	No	41	4.9
	Yes	791	95.1

Previous studies have shown that parents' education background has a significant impact on academic achievement [25]. A study conducted in Indonesia revealed that working mothers had children with higher educational attainment. This can be attributed to the stronger support system that mothers provide their children and their engagement in their children's education [26]. Our study showed a stronger relationship between mothers' education level and academic achievement, greater than fathers' academic achievement in the long and short term. Some studies in this field differ from this finding, showing that a higher education level among fathers is associated with academic achievement [27, 28]. In our study, four out of ten participants said that their parents' educational background had an impact on their educational attitude. This result was not significantly related to cGPA or GPA.

Children raised by parents with higher educational qualifications have greater aspirations and motivation toward learning [29]. Varying motivation levels toward learning affect academic achievement and noncognitive skills such as self-confidence, conflict management, stress management, and social responsibility, which in turn directly affects professional success, particularly in health professions [30].

The type of living situation (with relatives, family, or in student housing) had an insignificant impact on medical students' cGPA and GPA. Therefore, we believe that interactions with students, relatives or parents can support students and contribute to academic engagement and success. For example, greater levels of peer influence in student housing may affect academic achievement. Living with a family can also affect home and work responsibilities for students depending on SES. Each environment requires its own situation-specific measures and adjustments [31].

Participants with high family monthly income had higher standards of academic achievement in the long

Table 4 Association between non-educational factors and GPA in the last semester (*n* = 832)

		GPA Last semester					
		Fair (2–2.4)	Good (2.5–2.9)	Very good (3–3.4)	Excellent (3.5–4)	Poor (Below 2)	Pearson Chi-squared test
Age							0.37
	16–20	2	27	45	38	2	
	21–23	21	100	143	156	11	
	Above 23	14	75	113	82	3	
Sex							0.886
	Female	22	120	188	176	10	
	Male	15	78	110	98	6	
	Prefer not to tell	0	4	3	2	0	
Living condition during study:							0.328
	Family	21	122	175	182	8	
	Student housing	14	59	96	61	5	
	With relative	2	21	30	33	3	
Family monthly income							0.201
	Moderate	18	92	116	117	7	
	Very Low	8	23	28	23	2	
	Low	4	32	56	38	4	
	High	7	55	101	98	3	

Table 5 Association between educational factors and GPA in the last semester (*n* = 832)

		GPA last semester					
		Fair (2–2.4)	Good (2.5–2.9)	Very good (3–3.4)	Excellent (3.5–4)	Poor (Below 2)	*P*-value
Father's level of education							0.589
	Primary school	8	21	38	27	3	
	Secondary school	9	48	78	80	3	
	University	20	133	185	169	10	
Mother's level of education							0.319
	Primary school	10	40	42	39	3	
	Secondary school	15	61	112	96	5	
	University	12	101	147	141	8	
Parent's level of education affecting participants' educational attitude	No	18	133	178	160	11	0.196
	Yes	19	69	123	116	5	
Parents' support during learning process							0.648
	No	2	10	17	10	2	
	Yes	35	192	284	266	14	

Table 6 Association between non-educational factors and cGPA in the last semester (*n* = 832)

		cGPA last semester					
		Fair (2–2.4)	Good (2.5–2.9)	Very good (3–3.4)	Excellent (3.5–4)	Poor (Below 2)	*P*-value
Age							0.065
	16–20	5	17	54	37	1	
	21–23	24	105	175	121	6	
	Above 23	14	83	127	58	5	
Sex							0.721
	Female	26	123	215	146	6	
	Male	17	79	137	68	6	
	Prefer not to tell	0	3	4	2	0	
Living condition during study:							0.704
	Family	27	124	212	140	5	
	Student housing	12	61	105	53	4	
	With relative	4	20	39	23	3	
Family monthly income							0.019
	Moderate	17	97	148	83	5	
	Very Low	7	26	24	24	3	
	Low	11	25	66	30	2	
	High	8	57	118	79	2	

term, as demonstrated through their cGPA. Factors such as participant age and participant agreement that their parents' level of education affects their educational attitude, mother's level of education and father's level of education all affect cGPA and GPA but not significantly.

The findings of this study have significant implications for the educational landscape in Sudan, particularly given the current conflict and humanitarian crisis unfolding in the country. The data reveal that family income is a key determinant of academic performance among Sudanese medical students, underscoring the substantial educational disadvantages faced by students from low-income backgrounds. With widespread displacement, destruction of ho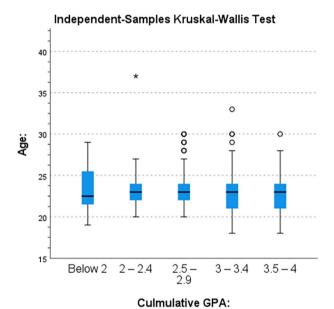mes and infrastructure, and disruption of essential services, the ongoing conflict has exacerbated economic hardships for many Sudanese families. This is likely to further exacerbate the educational disparities observed in this study, potentially widening the gap in academic achievement between students of higher and lower socioeconomic status.

The limitations of our study include that the survey was conducted only once due to the cross-sectional nature of the study. Therefore, it is difficult to establish the test-retest reliability of this study. It is also difficult to track recent changes in SES parameters, which have not had a significant impact on GPA. Another limitation is that the study was conducted using a convenience sampling method, which restricted the range of our sample. We

Table 7 Association between educational factors and cGPA in the last semester (*n* = 832)

		cGPA last semester					
		Fair (2–2.4)	Good (2.5–2.9)	Very good (3–3.4)	Excellent (3.5–4)	Poor (Below 2)	P-value
Father's level of education	Primary school	11	25	37	21	3	0.127
	Secondary school	8	54	92	62	2	
	University	24	126	227	133	7	
Mother's level of education	Primary school	11	41	53	25	4	0.119
	Secondary school	15	72	122	76	4	
	University	17	92	181	115	4	
Parent's level of education affecting participants' educational attitude	No	22	136	203	131	8	0.17
	Yes	21	69	153	85	4	
Parents' support during learning process	No	3	9	17	10	2	0.393
	Yes	40	196	339	206	10	

Fig. 1 Kruskal-Wallis test of age versus cGPA (*n* = 832)
This box plot represents the results of an Independent-Samples Kruskal-Wallis Test comparing age distribution across different cumulative GPA categories

consider the generalizability of our study to be a strength due to the ample sample size.

Conclusion and recommendations

Our research showed that family monthly income and age are significantly associated with academic achievement over a cumulative time period. Targeted interventions and policies to provide educational and financial support for students from disadvantaged backgrounds will be crucial to ensuring equitable access to quality education and promoting social mobility in Sudan during this challenging period. Equitable medical school admission systems must be adopted to support students from low socioeconomic backgrounds. Professional mentorships, grants and scholarships can be provided to support students from disadvantaged backgrounds and offset the effects of SES on academic achievement. Additionally, the significant role of parental education, particularly mothers' education, in influencing student attitudes and performance highlights the need to invest in improving educational attainment across all segments of Sudanese society for a more inclusive and prosperous future for the country's youth. Further research is needed to understand the effect of SES on noncognitive skills, which play a role in the success of health professionals. This awareness will further guide social initiatives addressing these disparities.

Abbreviations
GPA grade point average
cGPA cumulative grade point average
SES Socioeconomic status

Data availability

Declarations

Ethical considerations

Written ethical clearance and approval for conducting this research were obtained from the Faculty of Medicine, Alzaiem Alazhari University Ethical Committee. Participants' data were considered confidential. The participants all provided informed consent for the research, its objectives and its methodology. Since the research data will depend on a structured questionnaire from the patient, no harm is expected to result; nevertheless, full agreement was ensured in addition to privacy and secrecy.

Competing interests

The authors declare no competing interests.

Author details

[1]Faculty of Medicine, Alzaiem Alazhari University, Khartoum, Sudan
[2]Faculty of Medicine, Omdurman Ahlia University, Khartoum, Sudan
[3]Faculty of Medicine, Al-Ribat University, Khartoum, Sudan
[4]Faculty of Medicine, Sudan University of Science and Technology, Khartoum, Sudan
[5]Faculty of Medicine, Bahri University, Khartoum, Sudan
[6]Faculty of Medicine, Elrazi University, Khartoum, Sudan
[7]Faculty of Medicine, Bakht Alruda University, Khartoum, Sudan
[8]Faculty of Medicine, Ahfad University for Women, Khartoum, Sudan
[9]Faculty of Medicine, Omdurman Islamic University, Khartoum, Sudan
[10]Faculty of Medicine, University of Kordofan, Kordofan, Sudan
[11]Faculty of Medicine, Sinnar University, Sinnar, Sudan

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