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MEDICAL PROFESSIONALISM AMONG FUTURE PHYSICIANS

By

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Abstract

Introduction: Medical professionalism encompasses attitudes, values, and behaviours that health professionals must follow when performing their professions. **Aim of Work:** To assess professionalism among medical students at Zagazig University and to identify risk factors associated with lower levels of professionalism among them. **Materials and Methods:** A cross-sectional study was conducted among 425 medical students from different grades attending Faculty of Medicine, Zagazig University from March to May 2025. A self-administered questionnaire was distributed among participants to assess professional attributes and behaviours. **Results:** The current study included 425 medical students with age range from 18 to 30 years and mean age 21.27 years. Approximately 87% of them were Egyptians and 51.3% were males. About 31%, 36%, 39.8%, 54.4%, 40.8% of students had low commitment to patients' best interest, honesty and integrity, professional competency, patient safety and educational responsibility respectively and overall, 30.1% of students had inadequate professionalism. Increasing age, perceiving that studying professionalism is of no importance or neutral importance, no history of receiving any self-directed study or extracurricular studies on professionalism, no history of hearing about professionalism and no previous bad experience with physician significantly independently increase risk of unprofessional behaviour by 1.277, 26.186, 4.369, 1.745, 2.067 and 1.701 folds respectively. **Conclusion and Recommendations:** Inadequate professionalism is a current problem that needs to be addressed. Bad experience with unprofessional behaviour, depending only on curricular content, and lack of interest in professionalism can be addressed as risk factors. Educational program and extracurricular activities can improve professionalism and ensure competent care provided by future doctors.

Key words: Medical Professionalism, Medical students, Lack of interest and Undergraduate students.

Introduction

Medical professionalism encompasses all aspects of the profession's actions that demonstrate physicians are worthy trust of patients and the public. It can be characterized as "a whole set of attitudes, values, and behaviours that health professionals must follow when performing their professions" (Blank et al., 2003). The American Board of Internal Medicine (ABIM, 2001) characterized the essential components of professionalism as dedication to upholding the highest standards of excellence in the practice of medicine and in the creation and dissemination of knowledge, maintaining the interest and welfare of patients, and being responsive to the health needs of society. Medical professionalism has collected significant focus as a fundamental element in delivering high-quality patient care. This is due to its strong connections with enhancements in physician-patient relationships, improving patient satisfaction and career fulfilment for healthcare professionals, and potentially better healthcare outcomes (Li et al., 2017). Research indicates that professionalism greatly influences patient care and safety. Unprofessional actions endanger the well-being and safety of individuals receiving care. This scenario renders professionalism a competency domain for physicians (Tanrıverdi, 2022). According to international studies, doctors are dealing with a "value-threatening" issue and a decline in patient respect and trust, with a lack of professional identity among medical staff members being one of the main culprits. Acquiring all necessary medical knowledge and skills cannot guarantee success and confidence in medical practice unless a strong professional identity is formed and high standards in clinical and ethical aspects are demonstrated (Liang et al., 2020). One essential quality that future doctors should comprehend and cultivate as part of their identity is professionalism. (Jahan et al., 2016). Teaching and evaluating professionalism in undergraduate years assist medical students to improve their professional identity (Parthiban et al., 2021). Various researches have addresses medical professionalism among medical students in different countries: Parthiban et al., 2021among Asian students, Salih et al., 2012 from Saudi Arabia and Alhajri 2022 from Egypt, however to the best of the researcher knowledge there was limited study conducted in Egypt.

Aim of Work

The current study aimed to assess professionalism among medical students at Zagazig University and to identify risk factors associated with lower levels of professionalism among them.

Materials and Methods

Study design: It was a cross-sectional study.

Place and duration of study: The study was conducted at Faculty of Medicine in Zagazig University from March to May 2025.

Study sample: Medical students from different grades attending Faculty of Medicine in Zagazig University.

Sample size: The sample size was calculated using Epi info software program. Assuming that prevalence of students unfamiliar to concept of medical professionalism is 49.5% (Jamalabadi and Ebrahimi, 2018) and the total number of medical students at Zagazig University is about 8000, the sample size was 367. After adding 20% for non-response, the total sample was 440 students at precision level 95%; and design effect 1. A representative sample was chosen randomly from all grades proportional to their numbers using simple random technique. A total of 425 students were included as 15 students' reports were excluded from study due to absence of answers of more than 8 questions of Medical Professionalism: A Self-Assessment Tool (MPSAT) questionnaire.

Study methods: A self-administered questionnaire was distributed electronically among the selected students. The questionnaire was adopted from past study titled as "Medical Professionalism: A Self-assessment Tool" (MPAST) with a 5-component solution. MPAST is a valid and reliable tool with an overall Cronbach's alpha of 0.777 (Ho et al., 2023). It is composed of three sections:

Section 1: Personal characteristics as age, gender, nationality, grade level, residence, academic performance, receiving education in professionalism as a separate subject, suffering from chronic diseases, previous bad experience due to unprofessional behaviour.

Section 2: Four questions regarding the previous information about professionalism and its importance. A binary scale was used (NO= 0, Yes= 1).

Section 3 (Medical Professionalism: A Self-Assessment Tool;) (MPAST): It is a simple, easy administered 17-item questionnaire. It assesses five components which are commitment to patient's best interest, honesty and integrity, professional competency, patient safety and care, and educational responsibilities. Five Likert scale was used to assess this section (strongly agree=5, agree=4, neutral=3, disagree=2, strongly disagree=1). Total score ranged from 17 to 85 with higher scores indicated accepted professionalism. In the current study, we set cutoff value for professional behaviour to be ≥70% of total MPSAT scores.

A pilot study including 43 medical students was carried out to assess the clarity and understanding of the questionnaire. The results of this pilot study were excluded from the present study.

Consent

Informed consent was obtained from the participants after explaining the purpose of the study and ensuring that their participation is not obligatory and the anonymity of data.

Ethical Approval

Approval was obtained from the Research Ethical Committee of the Faculty of Medicine, Zagazig University, (ZU-IRB # 1017/16-2-2025).

Data Management

Data was entered and analyzed using the software SPSS (Statistical Package for the Social Sciences) version 26. Quantitative data was presented as mean and standard deviation while categorical data was displayed as frequencies and percentages. Data normality was assessed by the Kolmogorov–Smirnov test. The independent sample t test was used for comparing quantitative variables and normally distributed data. Moreover, when applicable, the Chi square test and Chi square for trend test were used. Binary logistic regression was used to identify risk factors associated with professionalism. P value less than 0.05 was considered statistically significance while $p \leq 0.001$ was considered highly significant.

Results

Table (1): Socio demographic characteristics of the studied participants.

	No=425	%
Gender		
Female	207	48.7%
Male	218	51.3%
Age (years)	21.27 ± 1.38	18 – 30
Academic year		
First	54	12.7%
Second	83	19.5%
Third	78	18.4%
Fourth	116	27.3%
Fifth	94	22.1%
Nationality		
Egyptian	371	87.3%
Sudanese	27	6.4%
Palestine	15	3.5%
Jordan	5	1.2%
Syrian	4	0.9%
Yemen	2	0.5%
Saudi	1	0.2%
Residence		
Rural	205	48.2%
Urban	220	51.8%
Accommodation		
With family	342	80.5%
With other colleagues	83	19.5%

Rank		
Failed	4	0.9%
Fair	6	1.4%
Good	43	10.1%
Very good	96	22.6%
Excellent	276	64.9%
Chronic diseases	62	14.6%
Family member work as a physician	125	29.4%
Have you heard about professionalism	313	73.6%
Do you study professionalism module?	282	66.4%
Self-directed study or extracurricular studies on professionalism	160	37.6%
Studying professionalism is		
Unimportant	8	1.9%
Neutral	106	24.9%
Important	311	73.2%
Bad experience due to unprofessional behavior	203	47.8%

The current study included 425 medical students with age range from 18 to 30 years and mean age 21.27 years. Approximately 87% of them were Egyptians, 51.3% were males, 61.8% came from urban areas, 64.9% had rank "Excellent" in previous semester and 14.6% had chronic diseases. About 20% and 27% of students studied in second and fourth academic year respectively. About 29% of them reported that one of their nuclear family works as physician and 47.8% had bad experience due to unprofessional behaviour of physician towards him or one of his family. On asking about the importance of studying professionalism, 73.2% reported that it is important indeed. About 66% studied modules on professionalism/professional practice, 73.6% heard about this term and 37.6% engaged in self-directed study or extracurricular studies on professionalism.

Table (2): Medical professionalism: A self-assessment Tool (MPSAT) items and domains.

MPSAT	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
	No (%)	No (%)	No (%)	No (%)	No (%)
Commitment to patients' best interests					
Physicians have an obligation to protect the confidentiality of the patient.	19(4.5%)	10(2.4%)	42(9.9%)	103(24.2%)	251(59.1%)
Physicians should put the patient's welfare above the physician's financial interests.	16(3.8%)	47(11.1%)	96(22.6%)	133(31.3%)	133(31.3%)
Physicians should provide necessary care regardless of the patient's ability to pay	23(5.4%)	18(4.2%)	74 (17.4%)	124(29.2%)	186(43.8%)
Physicians should minimize disparities in care due to patient race or gender	49(11.5%)	40(9.4%)	76(17.9%)	89(20.9%)	171(40.2%)
Mean ± SD	**15.77 ± 3.28**		**Range**	4 – 20	
Commitment to honesty and integrity					
I will omit learning about a certain condition or avoid speaking to a patient because the condition appears to be unimportant for examinations	81(19.1%)	162(38.1%)	116(27.3%)	53(12.5%)	13(3.1%)
I can report a part of the physical examination as normal when it forgets to do it during physical examination.	137(32.2%)	74(17.4%)	133(31.3%)	55(12.9%)	26(6.1%)
I should discuss sensitive and confidential information about patients in a public setting with insufficient precautions taken.	277(65.2%)	36(8.5%)	71(16.7%)	30(7.1%)	11 (2.6%)
I should keep learning opportunities to myself instead of sharing them with my peers.	176(41.4%)	76(17.9%)	111(26.1%)	37(8.7%)	25(5.9%)
Mean ± SD	**15.17 ± 3.46**		**Range**	4 – 20	
Commitment to professional competency					
Physicians should undergo recertification examinations periodically throughout their career	17(4%)	22(5.2%)	109(25.6%)	174(40.9%)	103(24.2%)

Physicians should report all instances of significantly impaired or incompetent colleagues to hospital, clinic, or other relevant authorities	25(5.9%)	45(10.6%)	148(34.8%)	154(36.2%)	53(12.5%)
Physicians should participate in peer evaluations of the quality of care provided by colleagues.	49(11.5%)	40(9.4%)	76(17.9%)	198(46.6%)	171(40.2%)
Mean ± SD	**10.88 ± 2.14**		**Range**	3 – 15	
Commitment to patient safety and care					
I can perform procedures beyond my capabilities under insufficient supervision.	144(33.9%)	71(16.7%)	135(31.8%)	49(11.5%)	26(6.1%)1
I will insist on talking to or examining a patient who is visibly tired or who refuse examination initially.	106(24.6%)	86(20.2%)	136(32%)	68(16%)	29(6.8%)
Physicians should disclose all significant medical errors to affected patients and/or guardians	29(6.8%)	51(12%)	135(31.8%)	146(34.4%)	64(15.1%)
I should inform the team in charge of a patient after I retrieve additional relevant information from the patient	18(4.2%)	4(5.6%)	112(26.4%)	92(21.6%)2	179(42.1%)
Mean ± SD	**14.32 ± 2.65**		**Range**	6 – 20	
Commitment to educational responsibility					
I have prepared myself well for my examinations and assessments in medical school.	10(2.4%)	18(4.2%)	111(26.1%)	153(36%)	133(31.3%)
I pay attention to staff members in lessons and contribute appropriately.	14(3.3%)	23(5.4%)	116(27.3%)1	142(33.4%)	130(30.6%)
Mean ± SD	**7.72 ± 1.7**		**Range**	2 – 10	
Mean ± SD of total score	**63.89 ± 9.0**		**Range**	36 – 84	

Table 2 showed MPSAT items and domains. Concerning commitment to patients' best interest domain, 59.1% strongly agreed that physicians have an obligation to protect the confidentiality of the patient, 31.3% of physicians should put the patient's welfare above the physician's financial interests, 43.8% strongly agreed that physicians should provide necessary care regardless of the patient's ability to pay, and 40.2% strongly agreed that physicians should minimize disparities in care due to patient race or gender. Mean score of this domain was 15.77 with a range from 4 to 20.

Concerning commitment to honesty and integrity domain, 19.1% strongly disagreed that one will omit learning about a certain condition or avoid speaking t because the condition appears to be unimportant for examinations, 32.2% strongly disagreed with that they can report a part of the physical examination as normal when it forget to do it during physical examination., 65.2% strongly disagreed with that they should discuss sensitive and confidential information about patients in a public setting with insufficient precautions taken, and 41.4% strongly disagreed with that they should keep learning opportunities to myself instead of sharing them with my peers. Mean score of this domain was 15.47 with a range from 4 to 20.

Regarding commitment to professional competency domain, 24.2% strongly agreed with that physicians should undergo recertification examinations periodically throughout their career, 36.2% agreed with that physicians should report all instances of significantly impaired or incompetent colleagues to hospital, clinic, or other relevant authorities, 40.2% strongly agreed with that physicians should participate in peer evaluations of the quality of care provided by colleagues. Mean score of this domain was 10.88 with a range from 3 to 15.

As regards commitment to patient safety and care domain, 33.9% strongly disagreed with that one can perform procedures beyond my capabilities under insufficient supervision, 24.6% strongly disagreed with that one can insist on talking to or examining a patient who is visibly tired or who refuse examination initially, 42.1% strongly agreed with that physicians inform the team in charge of a patient after I retrieve additional relevant information from the patient and 34.4% agreed with that physicians should disclose all significant medical errors to affected patients and/or guardians. Mean score of this domain was 14.32 with a range from 6 to 20.

Concerning commitment to educational responsibility domain, 31.3% strongly agreed with that one should prepare himself well for examinations and assessments in medical school, and 30.6% strongly agreed with that they pay attention to staff members in lessons and contribute appropriately. Mean score of this domain was 7.72 with a range from 2 to 10. Total score ranged from 36 to 84 with mean score 63.89.

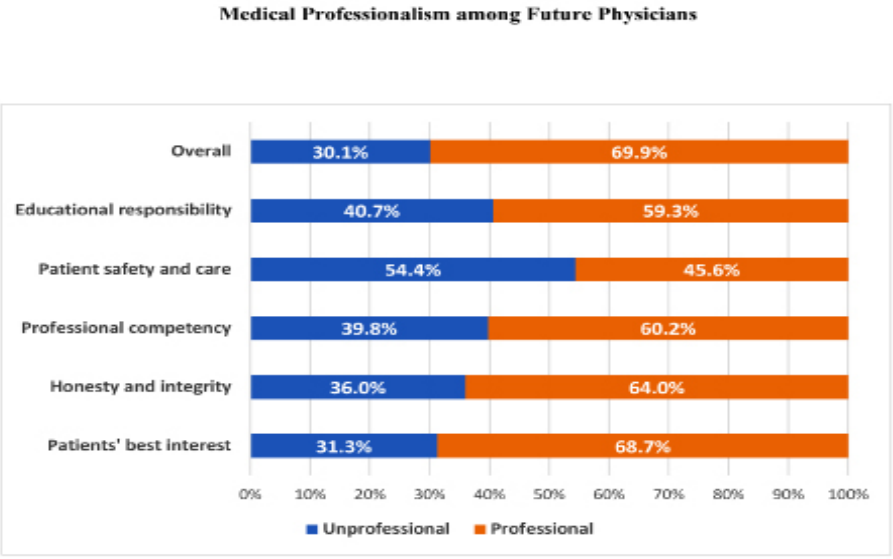

Figure (1): Bar chart showing distribution of participants according to unprofessional behaviour.

Taking ≥70% as a cut off for accepted professional behaviour, students were categorized as having professional behaviour in commitment to patients' best interest domain (68.7%), commitment to honesty and integrity domain (64%), commitment to professional competency domain (60.2%), commitment to patient safety and care domain (45.6%), commitment to educational responsibility domain (59.2%) and overall, 30.1% of students had inadequate professionalism (Figure 1).

Table (3): Relation between unprofessional behaviour and studied parameters.

	Professional No =297 (%)	Unprofessional No =128 (%)	χ^2	P- Value
Gender				
Female	151 (72.9%)	56 (27.1%)	1.801	0.18
Male	146 (67%)	72 (33%)		
Age (year) [mean ± SD]	21.13 ± 1.19	21.59 ± 1.71	t (-2.786)	**0.006***
Academic year				
First	41 (75.9%)	13 (24.1%)		
Second	60 (72.4%)	23 (27.6%)		
Third	52 (66.7%)	26 (33.3%)	3.006[¥]	0.083
Fourth	89 (76.7%)	27 (23.3%)		
Fifth	55 (58.5%)	39 (41.5%)		
Nationality				
Egyptian	265 (71.4%)	106 (28.6%)		
Non-Egyptian	32 (59.3%)	22 (40.7%)	3.317	0.069
Residence				
Rural	135 (65.9%)	70 (34.1%)	3.054	0.081
Urban	162 (73.6%)	58 (26.4%)		
Accommodation				
With family	214 (71.3%)	98 (28.7%)	1.78	0.182
With other colleagues	53 (63.9%)	30 (36.1%)		
Rank				
Failed	2 (50%)	2 (50%)		
Fair	3 (50%)	3 (50%)		
Good	28 (65.1%)	15 (34.9%)	7.529[¥]	**0.006***
Very good	57 (59.4%)	39 (40.6%)		
Excellent	207 (75%)	69 (25%)		

Family member work as a physicians				
NO	215 (71.7%)	82 (28.3%)	1.543	0.214
Yes	82 (65.6%)	43 (34.4%)		
Chronic diseases				
NO	256 (70.5%)	107 (29.5%)	0.486	0.486
Yes	41 (66.1%)	21 (33.9%)		
Have you heard professionalism				
NO	60 (53.6%)	52 (46.4%)	19.223	**<0.001****
Yes	237 (75.7%)	76 (24.3%)		
Do you study professionalism module?				
NO	82 (57.3%)	61 (42.7%)	16.101	**<0.001****
Yes	215 (76.2%)	67 (23.8%)		
Self-directed study or extracurricular studies on professionalism				
NO	171 (64.5%)	94 (35.5%)	9.587	**0.002***
Yes	126 (78.8%)	34 (21.3%)		
Bad experience due to unprofessional behavior				
NO	146 (65.8%)	76 (34.2%)	10.269	**0.001****
Yes	151 (74.4%)	52 (25.6%)		
Studying professionalism				
Unimportant	1 (12.5%)	7 (87.5%)		
Neutral	48 (45.3%)	58 (54.7%)	57.216¥	**<0.001****
Important	248 (79.7%)	63 (20.3%)		

t : independent sample t test $\chi 2$:Chi square test ¥: Chi square for trend test

*: $p<0.05$ is statistically significant **: $p\leq0.001$ is statistically highly significant

Table 3 showed that there was a statistically significant relation between unprofessional behaviour and all of student age, rank, if he/she heard about professionalism, receiving self-directed/extracurricular studies about professionalism, studying professional practice/professionalism module, bad experience due to unprofessional behaviour and attitude towards studying professionalism.

Table (4): Binary regression analysis of predictors of unprofessional behaviour.

	β	P-value	AOR	95% C.I.	
				Lower	Upper
Age	0.245	**0.004***	1.277	1.082	1.508
Study professionalism is important		**<0.001****			
It is unimportant to study professionalism	3.265	**0.003***	26.186	3.016	227.366
It is of neutral importance to study professionalism	1.475	**0.001****	4.369	2.658	7.183
NO history of receiving any self-directed study or extra-curricular courses in the context of professionalism	0.557	**0.03***	1.745	1.055	2.887
NO history of hearing about term ‹professionalism	0.726	**0.005***	2.067	1.242	3.439
NO previous bad experience with physician	0.531	**0.028***	1.701	1.060	2.729

AOR: adjusted odds ratio CI: Confidence interval

*:p<0.05 is statistically significant **:p≤0.001 is highly statistically significant

Table 4 displayed that increasing age, perceiving that studying professionalism is of no importance or neutral importance, no history of receiving any self-directed study or extracurricular studies on professionalism, no history of hearing about professionalism and no previous bad experience with physician; significantly independently increase risk of unprofessional behaviour by 1.277, 26.186, 4.369, 1.745, 2.067 and 1.701 folds respectively.

Discussion

Professionalism is a significant attribute for physicians that guarantees competent as well as compassionate patient care. Physicians ought to adhere to the maximum norms of ethical and professional conduct in all their encounters.

About 51% of students were males with age range from 19 to 30 years and 27.3% of them studied in 4th academic year (Table 1). In a previous study by Alkhater et al. (2021) they reported that 49.8% of students were males yet with almost age range as the studied students and 51.7% studied at 6th academic year. Alhajri and colleagues (2022) conducted a study on 296 medical students at King Faisal University, females constituted 71.3% and about 30% of students belonged to 4th academic year.

In the current study, about 70% of medical students adopted professional behaviour (Figure 1) that although being greater than other researches, it cannot be sufficient to warrant ideal care.

The best scored domains were commitment to patients' best interest domain (68.7%), then honesty and integrity domain (64%), followed by professional competency domain (60.2%), then educational responsibility domain (59.2%) and finally patient safety and care domain (45.6%) (Table 2) and overall, 30.1% of students had inadequate professionalism (Figure 1).

Starting from first year, medical students at Zagazig University studied professional practice module in which students learn communication skills and medical ethics. Patients' best interest, honesty/integrity and professional competency scored higher as they learn from commence how to identify patient as person not just disease in what is termed person-centred approach. So; even if they did not hear the term 'professionalism', they are well prepared to deal honestly with patients.

Educational responsibility, patient safety and care were the least scored domain (Figure 1). This can be attributed to that these domains could be recognized as necessity during field work in dealing with patients in a real situation. However, these areas need to focus upon in medical curricula.

In a previous Iranian study, more than half of students did not overhear about professionalism and 49.6% correctly replied to questions on knowledge about professionalism, yet with not significantly relation to

age or degree. However, females had significantly higher knowledge scores (Seif-Farshad et al., 2016). In a study done by Rasul et al., 2021, honour/ integrity had the best score while excellence/autonomy that corresponds to 'educational responsibility in the current research was the least scored domain (Table 2). In another research utilizing professionalism assessment tool (PAT), responsibility domain was the least scored one (Farasat et al., 2024).

Gender non-significantly relate to professionalism among the studied participants (Table 3). This advocates that the educational methods are gender neutral. This agreed with Eldeek et al, 2012. However, this came in disharmony with Alhajri et al., 2022 who found that male students had a significantly higher good insight in all domains. Spiwak et al., 2020; concluded that females were significantly highly likely to identify unprofessional behaviour. Midik et al., 2020 clarified that the student's descriptions of medical professionalism differed by sex.

Age played a significant role in decreasing professionalism score (Table 3 and 4), in agreement with earlier studies that displayed negative correlation between age and attitudes toward professionalism (Tashiya et al., 2021, Aleem et al., 2020 and Leaune et al., 2021). Alhajri et al., 2022 reported that a good perception of personal characteristics was detected among 97.1% of students at the pre-clinical academic years versus 85.5% of clinical years' students ($p<0.05$).

Alkahater, 2021 reported that the year two, students exert efforts to exceed ordinary expectations, while final year students tended to be overwhelmed with the stress of clinical clerkships.

This also can be attributed to that during clinical phase, as students come in contact with high-rate patient attendance in outpatient clinic, they perceive how ideal professionalism can be far away from what is actually present so they lack role models. Mohebi et al., 2018 advocated that the maximum inspiring component of professionalism, is role modelling

Role modelling has been critical in renovating medical students into medical professionals. To cultivate professional behaviour among future physicians, mentoring, role modelling, and consistent demonstration of professionalism are crucial (Eldeek, 2012).

The term 'hidden curriculum' means that students learn via the predesigned curriculum content but also, as well as role modelling. In a prior study, students emphasized that role models had utmost importance as they observed both positive and negative patterns of professional practice. This creates conscious and subconscious effects on students' own insight of professional expectations. Deliberately, students can be perceptive enough to adopt only positive elements of their role models (Sullivan et al., 2024). Nevertheless, students may also subconsciously adopt negative elements from their observed experiences as acceptable practice, despite initial concerns.

As students upgrade from just being peripheral members to be the central core in charge, concern arises about expected and accepted values and attitudes. It is therefore imperative that students are supplied with formal opportunities to reconcile hidden experiences with expectations as they move to centrality and while doing so, their own comprehension of professionalism will deepen (Farrington et al., 2019).

Not receiving self-directed study or extra-curricular courses in context of professionalism significantly increases risk of unprofessional behaviour (Table 4). Curiosity and volunteering to learn about professionalism mean that students perceive its importance and necessity to adopt professional behaviour. This can also explain why not hearing about term professionalism is another risk factor.

Previous bad experience due to unprofessional behaviour forces student to witness effect of a bad role model and how this can impair clinical outcome of patients. The student tends to adopt professional behaviour to avoid being a copy of such a bad model he had dealt with.

Conclusion

Inadequate professionalism is a current problem that needs to be addressed. Bad experience with unprofessional behavior, depending only on curricular content, and lack of interest in professionalism can be addressed as risk factors.

Recommendations

Perceiving importance of studying professionalism can help students adopt professionalism as when person feel that topic needed to be studied, he understands that it has deep roots and

it is not merely to honestly deal with patient. This helps them understand all domains of professionalism not just honesty or competency.

Educational programs and extra-curricular activities can improve professionalism and ensure competent care provided by future doctors. The corner stone to ensure professionalism is the presence of role models so practical clinical education via witness situations in which almost all physicians respect professionalism on dealing with patients can do more than studying many hours. So, long term sustained curricula on professionalism in line with adequate training especially in clinical phase with adherence to what is taught in theoretical part to be implemented during real situations with patients can bridge such gap and improve patient outcome.

Study limitations: This study had certain limitation; being cross sectional study with relatively small sample size. Tools despite valid; yet depending on self-reporting, on virtual situations without evaluation of behaviour on dealing with patients. Yet the study can act as baseline for further large-scale prospective studies.

Conflicts of interest

All authors have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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