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SPECIAL SERIES

Science Ethics Education
Part I. Perception and attitude toward scientific fraud among medical researchers

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Summary

Purpose: *To assess the knowledge of basic principles of responsible conduct of research and attitude toward the violations of good scientific practice among graduate biomedical students.*

Methods: *A total of 361 subjects entered the study. The study group consisted mainly of graduate students of Medicine (85%), and other biomedical sciences (15%). Most participants were on PhD training or on postdoctoral training. A specially designed anonymous voluntary multiple-choice questionnaire was distributed to them. The questionnaire consisted of 43 questions divided in 7 parts, each aimed to assess the participants' previous knowledge and attitudes toward ethical principles of science and the main types of scientific fraud, falsification, fabrication of data, plagiarism, and false authorship.*

Results: *Although they considered themselves as insufficiently educated on science ethics, almost all participants recognized all types of scientific fraud, qualified these issues as highly unethical, and expressed strong negative attitude toward them. Despite that, only about half of the participants thought that superiors-violators of high ethical standards of science deserve severe punishment, and even fewer declared that they would whistle blow. These percentages were much greater in cases when the students had personally been plagiarized.*

Conclusion: *Our participants recognized all types of scientific fraud as violation of ethical standards of science, expressed strong negative attitude against fraud, and believed that they would never commit fraud, thus indicating their own high moral sense. However, the unwillingness to whistle blow and to punish adequately the violators might be characterized as opportunistic behavior.*

Key words: attitude, continuing education, ethics, fraud, scientific misconduct

Introduction

Up until recently, the entire scientific community in Serbia was lacking the education and knowledge regarding scientific honesty and fraud. A group of enthusiasts, mainly MDs and PhDs, started in 2000 courses on science ethics within the framework of Continual Medical Education (CME); 12 such courses were held thus far [1]. Apart from this, many lectures were delivered at each Medical Faculty in Serbia (Belgrade, Nis, Novi Sad, Kragujevac) [2], and also on various occasions, including congresses and conferences [3].

Starting from 2006, PhD studies were introduced in the Medical Faculty of the University of Kragujevac, Serbia, and in the Faculty of Stomatology, University of Belgrade [4]. A mandatory course on science ethics was included. Several hundred of students have attended this course so far, only a minor number of them having previously been taught on science honesty.

We undertook this research with the aim to explore the awareness and attitude toward some violations of science ethics within a group consisting of attendees of the CME courses and PhD students.

Methods

Study population

A total of 361 subjects entered the study. This group consisted mainly of graduate students of Medicine (n=307; 85%), and other biomedical sciences (Ta-

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ble 1). Most participants were on PhD training or on postdoctoral training. Almost all of them were beginners in research, some already were a part of a research team, and a minority (older population, age ≥ 40 years) were experienced researchers. Other demographic characteristics are shown in Table 1.

Methods

A specially designed anonymous voluntary multiple-choice questionnaire was distributed to 450 graduate students of various biomedical sciences, and 361 were returned (response rate 80.2%). The questionnaire consisted of 43 questions divided in 7 parts. The first part consisted of 3 questions related to the previous science ethics education; the second part (6 questions) consisted of situations of false-gift authorship, and the students' attitude to this issue; the third part (6 questions) consisted of a situation in which juniors were affected by the misbehavior of their superiors regarding authorship; the fourth part (6 questions) dealt with fabrication of data; the fifth part (6 questions) consisted of a situation regarding falsification; the sixth part (9 questions) consisted of situations in which plagiarism was executed by superiors; the seventh part (7 questions) dealt with plagiarism executed by colleagues. In parts 2-7 the situation of fraudulent behavior that affected the third person was described, the students were asked to qualify it, and to propose sanctions against the violator. Then the students themselves were put in the same hypothetical situation of violated person, asked to qualify the violation and to propose the sanctions against the violator. Finally, at the end of the questionnaire, 6 questions related to the definitions of false authorship, plagiarism, falsification and fabrication of research data were asked in order to assess the participants' previous knowledge on these issues of scientific fraud.

Statistical analysis

Descriptive methods of statistical analysis (mean, median, N and percentages) were used to summarize the data obtained from the questionnaires.

Results

Only 18.6% of the participants had basic education on science ethics (SEE) obtained through seminars or courses, while more than half of them were self-educated. About one fifth had no education at all. Most (85.1%) thought that they need to learn more about this topic, since their previous knowledge was insufficient (37.7%), while 47.4% were not sure whether or not they were sufficiently educated on science ethics (Table 2).

Previous knowledge of scientific dishonesty

The definitions of falsification, fabrication of data and plagiarism were known to the great majority of the participants (72.6, 79.2 and 81.4%, respectively). Fewer participants knew all 3 criteria for authorship (4.7%), although 60.9% were acquainted with the document that

Table 1. The study group characteristics

Characteristics	*n (%)*
Age (years)	
Mean	31.04
Median	29
Sex	
Male	97 (26.9)
Female	257 (71.2)
No data	7 (1.9)
Education	
Medicine	307 (85.0)
Dentistry	7 (1.9)
Defectology	11 (3.0)
Pharmacy	6 (1.7)
Biology	3 (0.8)
Other	15 (4.2)
No data	12 (3.3)
High grades*	
Mean for the whole group	8.6
Total	361 (100)

*In Serbia, grades 9 and 10 are excellent grades; students whose mean grade during studies is ≥ 8.5 are candidates for PhD studies and therefore candidates for undertaking research

Table 2. The participants' previous education in SEE and their perception of the need for SEE

Characteristics	*n (%)*
Previous SEE	
Seminars/Courses	83 (23.0)
Self-education	194 (53.7)
No education	79 (21.9)
No data	5 (1.4)
Perception of need of SEE	
Useful	117 (32.4)
Necessary	226 (62.6)
Not useful	11 (3.0)
No response	7 (1.9)
Perception of previous knowledge of SEE	
Sufficient	47 (13.0)
Insufficient	136 (37.7)
Not sure	171 (47.4)
No data	7 (1.9)
Total	361 (100)

SEE: Science Ethics Education

provides the definition of the term and criteria to be met for authorship (Table 3).

False (underserved, gifted) authorship

With the intention to publish the main results of his MSc thesis, a young MSc graduate added the name of his superior to the byline, hoping to increase the chances for publication, although the latter had nothing to do with the research. Our participants qualified this act as common but wrong (58.7 and 97.2%, respectively), deserving warning (63.2%) or punishment (12.7%). Most participants had never done such a thing, either because they considered it as unacceptable behavior (45.7%), or because they had no opportunity to do it (42.7). A considerable percentage of the participants (56.8%) would not bestow undeserved authorship; however, 38.2% would, if they were forced to. A great majority (85.0%) would not accept gifted authorship (Table 4).

Ignored (neglected) authorship

In a study supervised by a professor, his young trainee contributed to a considerable extent. However, the trainee's name was omitted in the byline of the published paper. About two thirds of the participants never (31.6%) or rarely (33.8%) experienced such an event, but one third (32.7%) did, and they thought that this is common practice. As many as 95.0% of the students qualified this practice as wrong and unjustified, thus deserving either mere warning (60.4%) or even sanctioning (33.0%) the violator. Most participants never did or never would (98.6 and 96.1%, respectively) practise this type of misbehavior, mainly because they consider this practice as unacceptable. Two thirds (68.4%) of them would confront the violator, but about one third (30.5%) would not (Table 5).

Table 3. The participants' knowledge of all main types of the scientific dishonesty

Knowledge about	*n (%)*
Definitions	
Falsification	262 (72.6)
Fabrication	286 (79.2)
Plagiarism	294 (81.4)
Authorship criteria	
Yes	17 (4.7)
No	344 (95.3)
ICMJE document	
Yes	220 (60.9)
No	141 (39.1)

ICMJE: International Committee of Medical Journal Editors. Uniform requirements for manuscripts submitted to Biomedical Journals. Ethical Considerations in the Conduct and Reporting of Research. Authorship and Contributorship [5]

Fabrication of data

A trainee was told by his mentor that the results of his research are scarce and insufficient, thus requiring more experiments. Being overworked and lacking time, the trainee fabricates the data and submits it to the mentor for revision. Our participants never (45.4%) or rarely (34.6%) experienced such a situation, while 18.3% did. Almost all (99.2%) thought that such a behavior is wrong, but 8.3% (not shown) thought that it is justified. The violator should be warned (41.8%) or punished (54.0%). Most (96.1%) never had nor would (91.1%) fabricate data, but 7.2% thought that they would do it if needed. More than one third (37.7%) would uncover publicly this wrongdoing, but 58.7% would not (Table 6).

Falsification

Being unsatisfied with unconvincing results of his research, a researcher modifies data thus achieving sta-

Table 4. Perception and attitude toward gifted authorship

Undeserved (gifted) authorship	*n (%)*
Frequency of observed situation	
Never	65 (18.0)
Rare	81 (22.5)
Common	212 (58.7)
No data	3 (0.8)
Qualification of undeserved authorship	
Right	8 (2.2)
Wrong	351 (97.2)
No data	2 (0.6)
Sanctions of undeserved authorship	
No sanction	85 (23.5)
Warning	228 (63.2)
Punishment	46 (12.7)
Moderate	29 (8.0)
Severe	17 (4.7)
No data	2 (0.6)
Personal experience	
Had done	39 (10.7)
Had never done because of	321 (89.0)
No opportunity	154 (42.6)
Fear of punishment	2 (0.6)
Unacceptable	165 (45.8)
No data	1 (0.3)
Anticipation of future behavior	
Would do	154 (42.6)
If forced	138 (38.2)
If given the opportunity	16 (4.4)
Would never do	205 (56.8)
No data	2 (0.6)
Future acceptance of gifted authorship	
Yes	49 (13.6)
No	307 (85.0)
No data	5 (1.4)

Table 5. Perception and attitude toward ignored (neglected) authorship

Ignored (neglected) authorship	*n (%)*
Frequency of observed situation	
Never	115 (31.9)
Rare	122 (33.8)
Common	118 (32.7)
No data	6 (1.7)
Qualification of ignored authorship	
Right	3 (0.8)
Wrong	357 (98.9)
No data	1 (0.3)
Sanctions of ignored authorship	
No sanction	24 (6.6)
Warning	218 (60.4)
Punishment	119 (33.0)
Moderate	27 (7.5)
Severe	92 (25.5)
Personal experience	
Had done	3 (0.8)
Had never done because of	356 (98.6)
No opportunity	120 (33.2)
Fear of punishment	–
Unacceptable	236 (65.4)
No data	2 (0.6)
Anticipation of future behavior	
Would do	13 (3.6)
If forced	10 (2.8)
If given the opportunity	3 (0.8)
Would never do	347 (96.1)
No data	1 (0.3)
Would turn against violator	
Yes	247 (68.4)
No	110 (30.5)
No data	4 (1.1)

Table 6. Perception and attitude toward fabrication of data

Fabrication of data	*n (%)*
Frequency of observed situation	
Never	164 (45.4)
Rare	125 (34.6)
Common	66 (18.3)
No data	6 (1.7)
Qualification of fabrication of data	
Right	–
Wrong	358 (99.2)
No data	3 (0.8)
Sanctions of fabrication of data	
No sanction	12 (3.3)
Warning	151 (41.8)
Punishment	195 (54.0)
Moderate	77 (21.3)
Severe	118 (32.7)
No data	3 (0.8)
Personal experience	
Had done	7 (1.9)
Had never done because of	347 (96.1)
No opportunity	82 (22.7)
Fear of punishment	3 (0.8)
Unacceptable	262 (72.6)
No data	7 (1.9)
Anticipation of future behavior	
Would do	26 (7.2)
If forced	25 (6.9)
If given the opportunity	1 (0.3)
Would never do	332 (92.0)
No data	3 (0.8)
Would uncover publicly fabrication of data	
Yes	136 (37.7)
No	212 (58.7)
No data	13 (3.6)

tistically significant results. In our study group, 46.8% of persons never or rarely (34.9%) faced such a behavior, but 17.2% did. Almost all participants (99.7%) considered fabrication of research data as misbehavior that deserves warning or punishment (97.0%). Only two participants stated that they had falsified data. Most (97.0%) participants would never commit falsification, but 2.8% would do so if forced. Similar percentage of students (48.8%) would uncover publicly the other person's fraud, but 49.0% would not (Table 7). Regarding the public uncovering of the other person's fraud, our group was divided into 2 almost equal halves: 48.8% would do it, but 49.0% would not (Table 7).

Plagiarism

The situation where a professor plagiarized some parts of his student's thesis not citing the true author was something encountered by 46.5% of the participants, whereas 52.6% had never experienced such an event. Plagiarism was qualified as unpardonable behavior by 98.1%, but only 38.5% thought that it would be punished, and 52.6% thought that just a warning would be sufficient. With small exceptions (1.9%), the large majority (98.1%) of the participants had never plagiarized, nor would ever do so (94.5%). About half of the participants would uncover publicly the professor's plagiarism, while 44.3% would be unwilling to do so (Table 8).

Most participants never or rarely faced plagiarism that had occurred among coworkers (48.8% and 38.2%, respectively), while only 11.9% of them thought that it is a common behavior; 98.9% qualified this behavior as a highly dishonest act deserving warning or punishment (96.1%), of which only 56.5% would uncover it publicly. Almost all (98.9%) had never behaved dishonestly, either because they thought it is an unpardonable behavior (80.9%), or because of fear of punishment (1.4%), or because they had never been in such a temptation (16.6%). Similarly, almost all (96.1%) would never plagiarize the work of colleagues, but 3.3% would, if they had the opportunity or were being forced (Table 8).

However, should the student be wrongly accused

Table 7. Perception and attitude toward falsification of data

Falsification of data	*n (%)*
Frequency of observed situation	
Never	169 (46.8)
Rare	126 (34.9)
Common	62 (17.2)
No data	4 (1.1)
Qualification of fabrication of data	
Right	1 (0.3)
Wrong	360 (99.7)
No data	–
Sanctions of fabrication of data	
No sanction	11 (3.0)
Warning	126 (34.9)
Punishment	224 (62.0)
Moderate	81 (22.4)
Severe	143 (39.6)
No data	–
Personal experience	
Had done	2 (0.6)
Had never done because of	359 (99.5)
No opportunity	83 (23.0)
Fear of punishment	2 (0.6)
Unacceptable	274 (75.9)
No data	–
Anticipation of future behavior	
Would do	11 (3.0)
If forced	10 (2.7)
If given the opportunity	1 (0.3)
Would never do	350 (97.0)
No data	–
Would uncover publicly fabrication of data	
Yes	176 (48.8)
No	177 (49.0)
No data	8 (2.2)

Table 8. Perception and attitude toward plagiarism done by a superior or by a coworker

Plagiarism	*Professor n (%)*	*Coworkers n (%)*
Frequency of plagiarism		
Never	190 (52.6)	176 (48.8)
Rare	111 (30.8)	138 (38.2)
Common	57 (15.8)	43 (11.9)
No data	3 (0.8)	4 (1.1)
Qualification of plagiarism		
Right	7 (1.9)	4 (1.1)
Wrong	354 (98.1)	357 (98.9)
Sanctions of plagiarism		
No sanction	32 (8.9)	10 (2.8)
Warning	190 (52.6)	150 (41.6)
Punishment	139 (38.5)	200 (55.4)
Moderate	40 (11.1)	67 (18.6)
Severe	99 (27.4)	133 (36.8)
No data	–	1 (0.3)
Personal experience		
Had done	7 (1.9)	2 (0.6)
Had never done because of	354 (98.1)	357 (98.9)
No opportunity	94 (26.0)	60 (16.6)
Fear of punishment	–	5 (1.4)
Unacceptable	260 (72.0)	292 (80.9)
No data	–	2 (0.6)
Anticipation of future behavior		
Would do	18 (5.0)	12 (3.3)
If forced	15 (4.2)	10 (2.8)
If given the opportunity	3 (0.8)	2 (0.6)
Would never do	341 (94.5)	347 (96.1)
No data	2 (0.6)	2 (0.6)
Would uncover publicly		
Yes	187 (51.8)	204 (56.5)
No	160 (44.3)	147 (40.7)
No data	14 (3.9)	10 (2.8)

of plagiarizing the professor's paper (since the professor in his paper had not cited his student's work), 96.1% of the participants would warn (33.8%) or penalize (62.6) the professor. Similarly, if the participants were in the position of the plagiarized student, 93.63% would react by publicly announcing the professor's wrongdoing. On the other hand, if put in the professor's place, 77.8% would admit the fraud, while 18.8% would not (Table 9).

In the situation where the author of plagiarized non-published results finds that his/her colleague had plagiarized results and had already published a paper, the plagiator requests the original author not to publish his results and thus uncover his wrongdoing. When placed in the situation of the original (plagiarized) author, our participants would act differently (Table 9): 28.3% would publish results and would simultaneously make public the plagiator's dishonesty, 42.1% would publish the paper but would not undertake any measures against the plagiator, while 28.3% would refrain from publication but would either warn the plagiator not to repeat this wrongdoing (21.3%), or would uncover it

Table 9. Attitude toward the plagiator and the plagiarized author

Plagiarism	*Professor n (%)*	*Coworkers n (%)*
Attitude toward plagiator		
No measures against plagiator	9 (2.5)	
Warning	121 (33.5)	
Punishment	226 (62.6)	–
Moderate	59 (16.3)	
Severe	167 (46.3)	
No data	5 (1.4)	
As plagiarized author		
Would react publicly	338 (93.6)	198 (54.8)
Would not react	17 (4.7)	158 (43.8)
No data	6 (1.7)	5 (1.4)
As plagiator		
Would admit	281 (77.8)	
Would not admit	68 (18.8)	–
No data	12 (3.3)	

publicly (5.3%); only 1.7% would neither publish nor uncover the plagiarism (not shown).

In general, our students were more sensitive and expressed more negative attitude to plagiarism executed by colleagues-coworkers than to that of their superiors.

Discussion

In accordance with the Pan-European initiative for safeguarding good scientific practice, we started 10 years ago promoting responsible conduct of research within the Serbian scientific community [6,7] and beyond [8]. According to recommendations of numerous documents dealing with good scientific practice, special attention should be paid to the education of young scientists. That is why we started with courses/seminars on science ethics 10 years ago, being well aware that such an education is a real need not only in Serbia, but worldwide [9-13].

Unlike undergraduate medical students in Croatia, who learn about basic principles of science early during their studies [14], the Serbian medical students lack these lessons not only during basic studies, but also during postgraduate studies. Therefore, we were interested to know if they possessed any knowledge, and to what extent, in this important part of the education of researchers. We found that less than one fifth of our participants attended courses/seminars on science ethics, while the remaining lacked any formal education. Almost all think that their knowledge was insufficient, and that education in ethics is necessary, or at least useful, thus indicating their inclination for personal development to this direction.

In view of the lack of education in science honesty/dishonesty, it is rather surprising that most of our students recognized the definition of the most serious types of outright fraud –falsification and fabrication of data, and plagiarism– expressing strong negative attitude towards them. Such a honest behavior was reported by many undergraduate and graduate students in other reports [13,15]. On the other hand, recognition of criteria that should be met for authorship was considerably less successful –only 5% knew all 3 authorship criteria. The most frequent mistakes were misplacing the general supervision of the research team and the financial support of research into the authorship criteria. This seems rather odd, since over 60% of the participants were familiar with the document that, among other issues, defines authorship criteria [5]. Most participants considered false (undeserved, gifted) authorship unethical, believing that they would not do such a thing. However, they recognized it as a rather common issue, and a significant number of them thought that, although unethical, this act was justifiable and excusable. An earlier study [16] revealed that a high percentage of (co)authors who published in reputable medical journals (JAMA, Annals of Internal Medicine and British Medical Journal) had not met all authorship criteria and therefore were undeserved (honorary) authors, which justifies our participants' opinion that this is common practice.

Nevertheless, most participants declared that they would not consent to gifted authorship. On the other hand, the great majority of them would reprobate the superior who excludes his student from the byline, qualifying this act as a theft deserving punishment, which should be just a warning or mild punishment, while only one fourth insisted on an adequate penalty. Reluctance to report publicly the higher status person's wrongdoing regarding the authorship issue seems to indicate that the students consider themselves as vulnerable to retaliation, which was also found in earlier studies [17,18].

It seems that most examinees are aware that fraud is a real threat to research, since they condemned all three main types of fraud (falsification and fabrication of data, and plagiarism), but, as in other reports [19], a considerable percentage of participants endured this and would not make any allegations against perpetrators. A possible explanation for this could be that, although they know their institutions have codified rules for handling allegations of scientific misconduct [6,7], which also protect the whistle blowers, they are still aware that whistle blowers often suffer retaliation and mobbing [20-22]. This may be due to poor handling of allegations, or reluctance of the local authorities to impose sanctions against the malefactor, or even the tendency of universities to hide this kind of scandal [22-25]. In contrast, countries that have enforced federal scientific misconduct regulations (Office of Research Integrity, USA) take fraud very seriously and impose sanctions against violators [26], for "Where institutions fail to act against perpetrators of misconduct, science itself is the loser"[27].

Nevertheless, many think that the most important way to reduce academic misconduct is teaching on science ethics to both undergraduate and graduate students [28-37]. Expressing their need to learn more about science ethics and scientific misconduct, our participants have confirmed that they share this opinion. However, although they believe their knowledge of science ethics is insufficient, almost all the participants recognized all types of scientific fraud, to which they were strongly opposed. Despite the fact that most of them qualified these issues as highly unethical, a smaller number of the participants thought that violators of high ethical standards of science deserve adequate punishment, and even less declare that they would whistle blow. This attitude might be explained by the awareness of perils the

whistleblowers may experience, but also, this may be qualified as opportunistic behavior.

In our next paper we shall report the impact of our teaching on responsible conduct of research on the same sample population reported in this article.

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