



Research article

Awareness and knowledge of manuscript writing and research integrity: A cross sectional survey among graduate students[☆]Fadia Mayyas^{*}, Karem Alzoubi

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ABSTRACT

Graduate students face a variety of barriers when writing manuscripts. The major barrier is inadequate writing experience and training. We aimed to evaluate the awareness and the knowledge of the basic principles in manuscript writing and research integrity among graduate students, and to assess the usefulness of workshops to improve their knowledge about manuscript writing process. A cross sectional survey was developed to evaluate the awareness and the knowledge about the manuscript writing steps and the research integrity among graduate students in Jordan. A one-day workshop about manuscript writing and research integrity was conducted. Students (n = 285) completed the questionnaire. Most participants were female masters' students. Although 83.8% of the students were aware of the general manuscript structure, most of them were not aware of the basic concepts to write most manuscript sections. Only 22.5% of the students were aware of the authorship criteria. Data showed a lack of knowledge of different practices of scientific misconduct. Barriers in manuscript writing included the lack of focused research methodology courses and the lack of professional workshops and the absence constructive mentorship support. The workshop was useful in introducing the key concepts in manuscript writing. The present study revealed a lack of knowledge among graduate students about manuscript writing and scientific misconduct. Professional workshops are useful in improving students' knowledge.

1. Introduction

The research status in any community is one of the key estimates of scientific progress [1]. Thus, conducting a precise and ethical research in different fields of studies is critical to resolve the emerging life problems and explore the new possibilities [1]. Understanding of research integrity and writing process is an essential matter for all researchers, especially, junior graduate students [2, 3]. Graduate students perform different writing tasks throughout different degree programs [4]. Graduate students are expected to write a dissertation thesis that may lead to one or more publications. Many institutions require that graduate students (especially in the Ph. D. program) submit or publish original research papers to scholarly journals or conferences as a condition for graduation [5]. At the institutions where the present study was conducted,

submission of a research article to an indexed journal is a condition for graduation at the graduate study level. Most students at our institutions are required to complete their didactic courses in the first to the second years of the study before they start research or practical training in the chosen graduate program. Thus, it is expected that students will write their manuscripts later after the first two years of the program. Students should be familiar with the essential concepts and tools for writing and preparing research manuscripts. Graduate students face a variety of barriers when writing manuscripts for publication [1, 6]. The major barrier is the inadequate writing experience and training especially for non-native English speakers [7]. Other barriers include insufficient knowledge of the study design, lack of experience in the interpretation of study results, inadequate knowledge of statistics and data analysis and little support from the mentors [6]. Strategies to encourage graduate

[☆] Some graduate curricula include courses or training in scientific manuscript writing and publication. When students' writing skills are not sufficient, their mentors might be forced to write the whole manuscript or spend a considerable time and effort correcting the student's draft [8]. In addition, collaboration studies that result in multi-author publications may obscure the real contributions of graduate students. The use of commercial language editing services may also reduce the students' chance to learn enough about writing a manuscript [8]. Thus, training in scientific manuscript writing in different fields of studies should be a standard component in the curriculum of graduate study. The training for English writing is particularly important for non-native English speakers who have good research to publish [7]. Training in technical writing skills and manuscript formatting were also recommended by applied epidemiologists [13].

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Table 1. Characteristics of Study participants.

| Students Characteristics | N = 285, Graduate Students |
|--|----------------------------|
| Gender (Female, %) | 204 (71.6) |
| Age (mean \pm sem) | 26.24 \pm 0.2 |
| Master program | 274 (96.1) |
| Ph. D program | 11 (3.9) |
| Current stage (n, %) | |
| Course stage | 107 (37.5) |
| Experimental work | 81 (28.4) |
| Thesis writing | 64 (22.5) |
| Manuscript writing | 33 (11.6) |
| Duration (n, %) | |
| 1st year | 89 (31.2) |
| 2 nd years | 116 (40.7) |
| 3rd years | 70 (24.6) |
| 4rth year | 10 (2.9) |
| Manuscript draft (Yes, %) | 105 (36.8) |
| Faculty (n, %) | |
| Medicine | 22 (7.7) |
| Dentistry | 4 (1.4) |
| Pharmacy | 64 (22.5) |
| Nursing | 11 (3.9) |
| Applied Biomedical Sciences | 29 (10.2) |
| Science | 53 (18.6) |
| Veterinary Medicine | 5 (1.8) |
| Engineering | 33 (11.6) |
| Agriculture | 16 (4.6) |
| Computer IT | 8 (2.8) |
| Architecture | 7 (2.5) |
| Economy, management, and accounting | 33 (11.6) |
| Missing data | 10 (2.85) |

students' participation in research studies include adequate training on manuscript writing. A previous series of books on academic writing for graduate students published by John Swales and Christina Feak aimed at developing communication skills in academic writing and explaining writing strategies [7]. The writing strategy considers the audience, the purpose of the paper, the style, and the academic genre using task-based methodology and group discussions [7]. This type of methodology is very useful when writing a manuscript as it shows how to write summaries and critiques and includes feature sections focusing on language to address linguistic elements, and help students to position themselves as junior scholars in their academic communities [7].

Lack of knowledge about manuscript writing and research ethics reduces the probability of publication and threatens the integrity of the research [8]. The scientific journals depend on the trust that all individuals involved in the manuscript including authors, reviewers, and editors follow the rules and ethics of scientific integrity [9]. Scientific research requires the implementation of research ethics in all the aspects of research including writing. Guest/ghost authorship, plagiarism, falsification, fabrication, and other forms of scientific misconduct are important challenges for the research integrity that the graduate students should be aware of [9].

Training workshops are one of the most effective methods to improve students' writing skills and ethical knowledge. A previous study has assessed the impact of workshops on researchers' the writing skills and the capabilities of researchers and found a significant impact of the training workshops on the knowledge of the participants [10]. In this present study, graduate students' level of awareness and knowledge of manuscript structure and key elements in writing were examined. Important ethical aspects of writing and publication and the pitfalls associated with them were also assessed. The usefulness of training

workshops to improve students' knowledge and writing skills was also determined.

2. Methods

Ethical statement

The study protocol was approved by the institutional review board of King Abdullah University Hospital (KAUH) and Jordan University of science and technology (JUST), IRB approval number 22/115/2018. All participants gave informed consent prior to participation. The study was conducted according to the principles of Declaration of Helsinki, 1975.

2.1. Study design

This is a cross sectional survey study that was conducted in the period of June–August 2018 and October–December 2019. We have followed the recommendations for reporting survey base studies to describe the essential tools of survey design, validation and dissemination as previously described [11]. Inclusion criteria were graduate students from medical and non-medical faculties at two public universities in Jordan. A research assistant (RA) was assigned to visit different faculties at the two universities and meet the graduate students during the break time between their classes. The RA distributed the hard copies of the questionnaire randomly and described all items to the participants. The students who showed an interest in participation were able to consult the RA who answered any questions raised by them and insured that all items were completed by participants. The RA collected the completed questionnaires on site immediately. Data were received on a single excel file and handled by one researcher.

A questionnaire was developed and tested to evaluate the students' awareness and knowledge. It was written and distributed in English language. The questionnaire was developed based on ideas identified in the existing literature [2, 6, 12, 13]. The questionnaire (attached) is comprised of 44 questions divided into four sections, regarding (1) demographics, (2) awareness and knowledge of manuscript structure, (3) awareness and knowledge of research integrity and scientific misconduct, and (4) barriers to manuscript writing. The questionnaire included a cover letter explaining the purpose of the study and data anonymization as no identifiable information was collected. All study questions were multiple choice, check boxes, and rating scale questions [11]. The content and face validity of the questionnaire was examined by two trained faculty members and piloted by 15 graduate students from pharmacy, engineering, and medicine faculties. The feedback was collected, and the questionnaire was edited per comments from the pilot study. A reliability test was performed to evaluate the internal consistency of the questionnaire and produced a Cronbach's alpha value of >0.7 for each set of questions (Supplementary table 1).

A one-day workshop was conducted to introduce a sample of the participants to essential concepts in writing and important ethical aspects associated with writing. An announcement about the workshop was emailed to all graduate students both universities. More than 120 students were interested to participate; however, thirty-three graduate students were selected on the first-come, first-served basis due to the limited resources and the nature of the interactive workshop that include small group discussions. The workshop was given by an experienced fellow at the responsible conduct of research program in Jordan.

Supplementary table: Reliability of questionnaire items.

| Number of questions (Q) in the questionnaire | Scope | Cronbach's alpha |
|--|---|------------------|
| Q8-10 | Awareness of IMRAD structure | 0.76 |
| Q11-27 | Level of agreement on aspects of manuscript structure | 0.71 |
| Q28-33 | | 0.79 |

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| Number of questions (Q) in the questionnaire | Scope | Cronbach's alpha |
|--|--|------------------|
| | Knowledge of manuscript structure | |
| Q34-36 | Awareness of ICMJE criteria | 0.82 |
| Q37-39 | Level of agreement on some ethical practices | 0.77 |
| Q40-43 | Knowledge of some practices of scientific misconduct | 0.75 |
| Q44 | Barriers in manuscript writing | 0.81 |

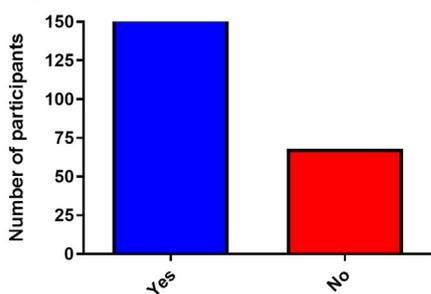
IMRAD: introduction, method, result and discussion; ICMJE: international committee of medical journal editors

2.2. Workshop contents

The workshop provided participants with a step-by-step guide to write a manuscript with a strong interactive focus. Topics that were discussed included the steps in the development of a research paper: writing the title, the abstract and the introduction, setting the study objectives, describing the methodology, data analysis, writing the results, preparing the figures and tables, the discussion, conclusions, and managing references. Tips for getting manuscripts published in indexed journals were briefly discussed. Important aspects of research misconduct such as conflict of interest, authorship criteria, plagiarism, falsification, photo manipulation, fabrication and their consequences were

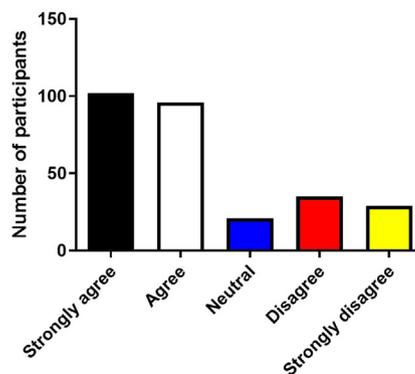
A

Are you aware of the IMRAD structure of the manuscript?



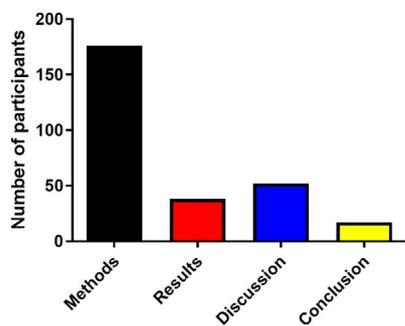
B

The abstract is the first section to be written in the manuscript?



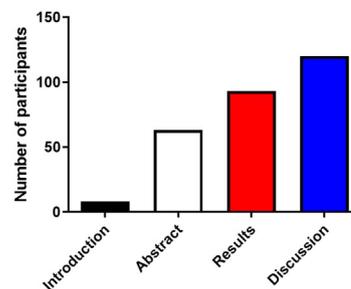
C

The section that presents the characteristics of your study samples is?



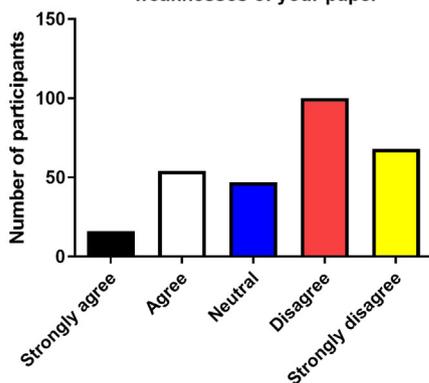
D

The section that answers your research question and summarizes where your findings fit in the existing body of evidence is?



E

The limitation section is not necessary because it shows the weaknesses of your paper



F

You should write in the past tense when describing what you did and when describing what is known?

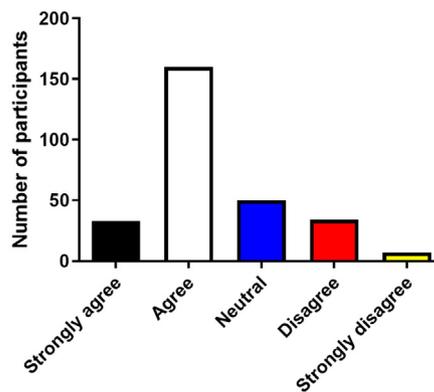


Figure 1. Knowledge of Manuscript Structure. A–D represents number of participants responded to various study questions related to manuscript structure. Number = 285.

discussed at the last session as a part of the manuscript writing process. The workshop content was developed based on existing workshops and from ideas shown to work in previous studies [1, 14].

Students (33 students) completed a post questionnaire, which is similar in content to the pre-questionnaire. However, the last section (barrier in manuscript writing) was not included again (the questionnaire, supplementary material)). The workshop was given in a form of lectures (PowerPoint presentation) that included practical exercises and different cases. Questions, comments, and problem-based scenarios were presented and discussed through individual questions and team activities with important feedbacks and interactions from students.

The questionnaire was distributed to participants before and immediately after conducting the workshop to evaluate the efficacy of the workshop in increasing the students' awareness and knowledge of manuscript writing tips avoiding any confounding factors that may interfere with the outcome later after the workshop.

3. Statistical analysis

Age was expressed as mean ± standard error, whereas categorical variables (e.g., gender, current stage, Yes/No and agreement level questions etc.) were expressed as numbers and percentages. To evaluate the impact of the workshop on students' responses, agreement statistics were performed using the McNamar's- Bowker chi square test for paired categorical data analysis. Sample size calculation revealed that 230 students were required to achieve a power of 90%, however, a higher number of students who agreed to participate was included to increase the power of the analysis. Data were collected and entered in JMP Pro 13.2.1 software (SAS Institute Inc, USA). Figures were produced using GraphPad Prism 9 (GraphPad Software, LLC). Statistical significance was examined at a *p* value < 0.05.

4. Results

4.1. Characteristics of study participants

Graduate students (n = 285) agreed to participate, which accounted for about 75% of original study population (n = 380). About 72% of the students were females and 96% of them were master students, whereas 4% were Ph.D. students. About 37.5% of the participants were in the course stage and 28.4% and 34.1% were in the experimental work, and thesis or manuscript writing stages, respectively. Around 72% of students were in the first and the second year of graduate study. About 37% of students had a manuscript draft at the time of participation. Approximately, 47.4% of the students were in the medical field. On the other hand, 18.6% and 11.6% were students at faculties of Sciences and Engineering, respectively (Table 1).

4.2. Awareness and knowledge of manuscript structure

In this section, awareness and knowledge of the general and basic concepts in manuscript writing were evaluated.

Although 83.8% of students (Figure 1 A) were aware of the general IMRAD structure (Introduction, Method, Result, and Discussion structure), most of them were not aware of detailed tips in writing. For example, 35.8% and 33.7% of the students strongly agreed and agreed that the abstract is the first section to be written in the manuscript (Figure 1 B). In addition, 62.2% of the students thought that the method section rather than the result section should present the characteristics of study sample (Figure 1 C). When students were asked about the section that presents research question and summarizes where the results of the study fit in the existing body of literature, responses varied significantly with only 42% of students answered the discussion section correctly, whereas 32.6% answered the results section, and 22% answered the abstract section, Figure 1 D. With respect to students' knowledge of the limitation section, about a quarter of the students found it an unnecessary

Table 2. Awareness of manuscript structure.

| | Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree |
|---|----------------|-------|----------------------------|----------|-------------------|
| Per your knowledge, the title of the manuscript should provide informative description of the study population, design, intervention, and outcome measure. | 21.1 | 52.6 | 9.8 | 14.4 | 2.1 |
| Per your knowledge, the abstract should illustrate study objectives, setting, population, methods, major findings, and brief conclusion. | 44.6 | 43.2 | 7.4 | 3.9 | 1.0 |
| Per your knowledge, when writing the introduction of the manuscript, you should move from broad to detailed information? | 30.2 | 48.1 | 11.6 | 8.1 | 2.1 |
| Per your knowledge, the first paragraph of your introduction should define the problem. | 21.8 | 41.5 | 11.6 | 20.8 | 4.2 |
| Per your knowledge, the method section should describe what was done and when and define all variables in the results. | 24.1 | 53.2 | 11.7 | 8.9 | 2.1 |
| Per your knowledge, the results of the study should be written in objective manner (just the dry facts). | 19.6 | 44.5 | 19.3 | 14.0 | 2.5 |
| Per your knowledge, the discussion section should start with statement of major finding (answer research question). | 17.5 | 50.8 | 20.4 | 9.5 | 1.7 |
| Per your knowledge, the reference list should be formatted per journal style, and includes accurate information that allows the reader to find it in the public domain. | 40.1 | 49.6 | 7.0 | 2.5 | 0.7 |

Data are presented as percentages %. Number = 285.

section because it shows the weaknesses of the manuscript, while other students were either neutral (16%) or strongly disagreed/disagreed (59%), Figure 1 E.

In general, writing in the past tense is usually used when describing what has been done, and the present tense is used when describing what is known. About 11.6% and 56% of students strongly agreed/agreed that the past tense should be used when describing both what is known and what has been done (Figure 1 F).

Table 2 shows graduate students' responses to additional questions related to knowledge of manuscript structure and writing tips. A variation in responses was found with a range of ~63–89% of students strongly agreed and agreed on most of survey questions. A significant percentage of students was aware of the purposes of the title (73.7%) and the abstract (87.8%), and 89.7% were aware that the reference list should be formatted per journal style. About 10.2% of students were unaware of what to discuss when start writing the introduction, 11% were unaware of what to report in the method section 16.5% were unaware of how to report study results, and 11% were unaware of how to start writing the discussion (Table 2). On the other hand, about 7%–24% of students were neutral about survey items. The knowledge of manuscript structure was associated with the stage of the study. In general, the knowledge of manuscript sections was not correlated with students' stage of the study for most of questionnaire questions (*p* > 0.05). However, for few questions, the proportion of aware students was higher in the manuscript/thesis writing stage than in the course stage. This was true for items related to awareness of general IMRAD structure (questions 9, 10) *p* < 0.01.

4.3. Awareness and knowledge of research integrity aspects

In this section, the awareness and the knowledge of distinct types of the scientific misconduct, the authorship criteria, and the concept of conflict of interest were evaluated. Only 22.5% (n = 64) of the students were aware of the international committee of medical journal editors (ICMJE) authorship criteria (data not shown). Students differed in their knowledge of each of the ICMJE authorship criteria; 42

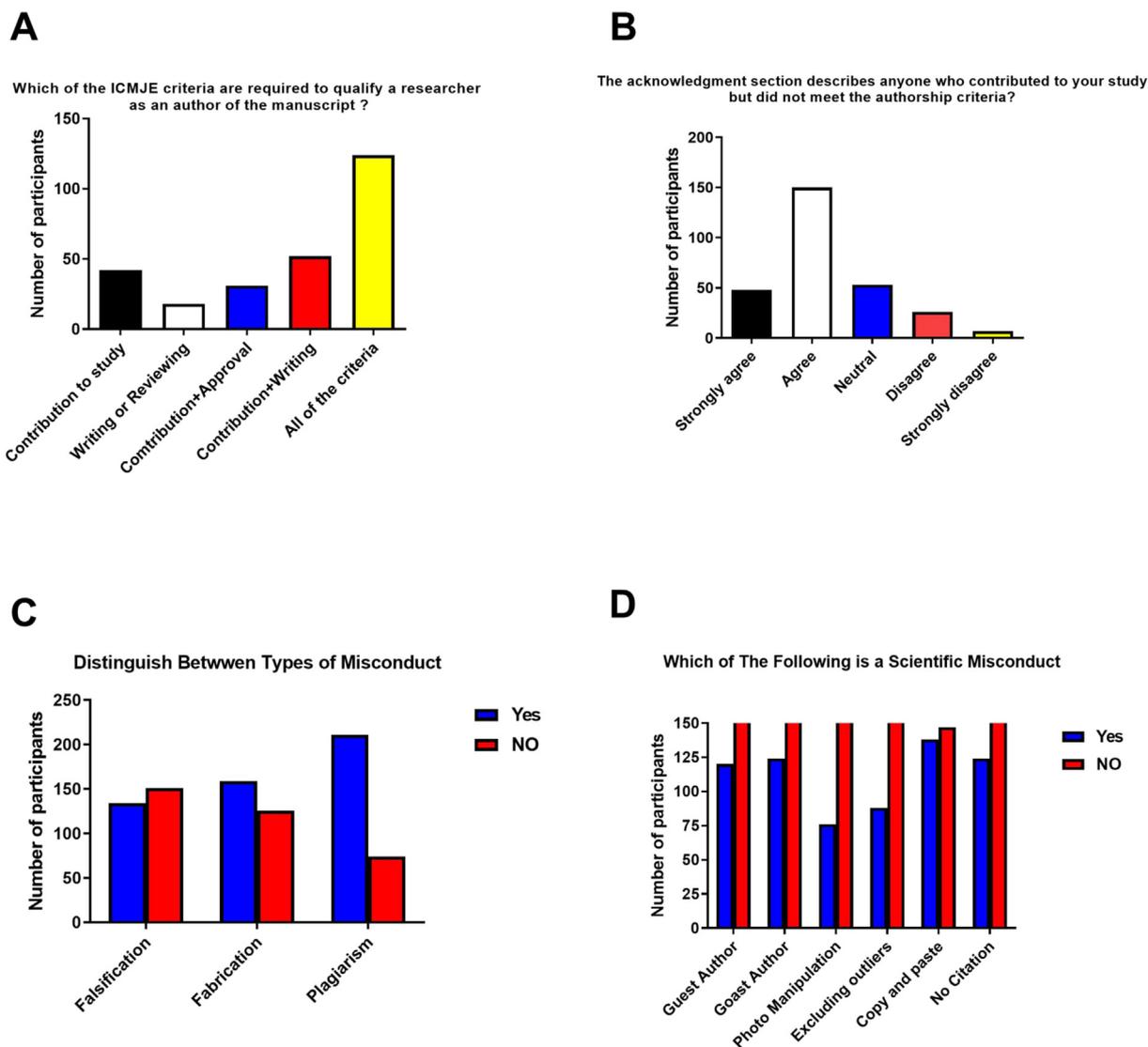


Figure 2. Awareness of scientific misconduct and authorship criteria. Represents number of participants responded to various study questions related to authorship criteria (A–B) and types of scientific misconducts (C–D). Number = 285.

students considered contribution to study design and analysis as the qualifier for authorship, 18 considered drafting/reviewing of the paper, 52 considered contribution to study design and writing, 31 considered contribution to study design and approval and 124 considered that all criteria should be met to fulfill authorship (Figure 2 A). In addition, 69.7% of students agreed and strongly agreed that the acknowledgment section should recognize those who contributed to the study but did not meet all the authorship criteria (Figure 2 B). With respect to scientific misconduct, about 48%, 57.2%, and 75.3% of the students were able to define falsification, fabrication, and plagiarism; respectively (Figure 2 C). Interestingly, 209 and 197 students did not consider manipulation of research images and excluding outliers as forms of scientific misconduct; respectively (Figure 2 D). Guest/ghost authorship, no citations of others’ opinions, and copying/pasting were considered as practices of misconduct by more than 50% of students (Figure 2 D).

4.4. Barriers to manuscript writing

In this section, the students were asked to select barriers to manuscript writing (Figure 3). Several barriers were selected by the students, but 50.2%, 46.0%, 49.5% and 43.5% of them considered the lack of

writing skills, the lack of focused research methodology courses, the lack of research experience during undergraduate study and the lack of training workshops as the most encountered barriers, respectively. Other barriers were the lack of constructive mentorship, time, research conferences, and incentives for manuscript writing, Figure 3.

4.5. Effectiveness of the workshop in improving the awareness and the knowledge of the manuscript writing process

Students (n = 33) participated in the workshop: 2 Ph.D. students and 31 master students. Relative to baseline, there was a significant improvement in the knowledge of manuscript structure and tips in writing specific sections after conducting the workshop. For example, twenty-six compared to six students strongly agreed that the first paragraph of the introduction should define the problem of the study (Figure 4 A). In addition, twenty-seven compared to four students strongly agreed that the results should be written in an objective manner (Figure 4 B), and twenty-two compared to four strongly agreed that the discussion section should discuss the implications of the study (Figure 4 C). Moreover, twenty-two students disagreed that the limitation section is not necessary relative to thirteen students at baseline (Figure 4 D), p < 0.0001 for all analyses.

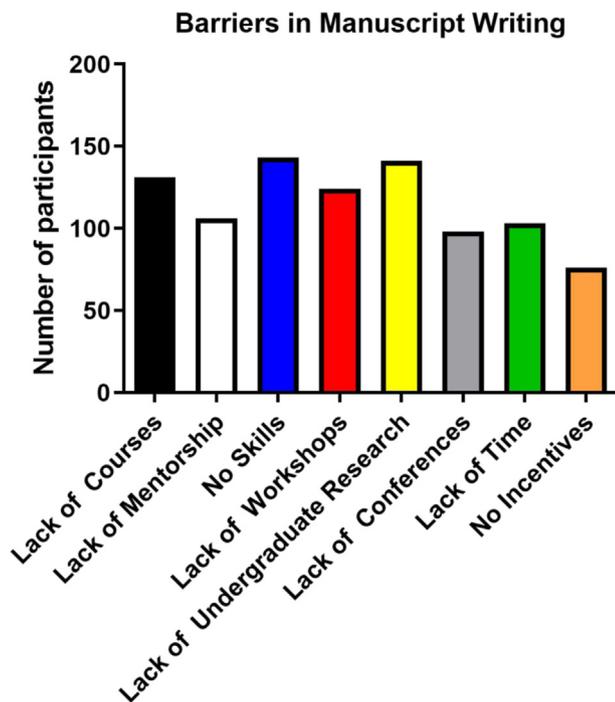


Figure 3. Barriers in manuscript writing among graduate students. Represents number of participants responded to various barriers in manuscript writing. Number = 285.

4.6. Effectiveness of the workshop in improving the awareness and the knowledge of scientific misconduct

Overall, there was a significant improvement in the awareness and the knowledge of the types of scientific misconduct and the ability to distinguish between them. For example, twenty-seven students relative to seven at baseline were able to define fabrication, and twenty-nine relative to eighteen at baseline defined falsification, [Figure 5 A](#). In addition, students were able to define some practices of scientific misconduct after the workshop ([Figure 5 B](#)). For instance, twenty-eight compared to five at baseline agreed that photo manipulation is a practice of misconduct, and twenty-six compared to seven considered excluding outliers without disclosure as a form of misconduct. The workshop significantly increased the students' awareness and knowledge of authorship criteria ([Figure 5 C](#)). Twenty-nine students became aware of the ICMJE criteria. All students relative to ten students at baseline agreed that the four criteria of the ICMJE should be fulfilled to qualify researchers as eligible authors ([Figure 5 D](#)).

5. Discussion

Publication in good journals is an important measure to evaluate academic performance and achievements for researchers. Nevertheless, practical and language barriers may limit the ability of writing and publication mainly for beginners such as graduate students [15]. We have evaluated graduate students' knowledge of key preparatory steps for writing a good manuscript. A significant lack of awareness and knowledge of manuscript writing tips and some scientific misconduct practices were found. Students defined several barriers to writing manuscripts such as lack of mentorship support, lack of research experience during undergraduate studies and lack of training workshops. Although research methodologies courses are offered as core courses in most graduate programs, they are inadequate and provide a limited experience to write research papers and theses at many institutes.

Manuscript writing is an essential skill for all researchers; however, it seems that many of them are unaware about writing research papers. In

an online survey among Croatian surgeons, 68% of respondents initially claimed to know about medical writing, however, further questioning revealed a reduced level of familiarity with medical writing [2]. Another survey among undergraduate and postgraduate medical students in Shiraz revealed that students showed favorable knowledge of research, but their attitude to the field was inadequate [6]. In our study, most of the students were aware of the general manuscript structure, however, a considerable proportion was not knowledgeable or neutral about key concepts when writing manuscript sections.

The IMRAD structure is recommended for writing studies submitted to the biomedical journals and has become the most important guide to writing and publishing in more than 500 international journals [1]. The IMRAD structure is not uniform across disciplines as different fields may have distinctive style formats and different journals may favor different structures. However, since we cannot survey all style formats, we considered the IMRAD structure as it is not an arbitrary writing format but a direct reflection of scientific discovery process. Further, it facilitates modular reading and finding of specific information in different sections [1, 16]. The results of the current study revealed that many students were not knowledgeable of the basic concepts to be included in each manuscript section. There was a lack of clarity regarding the purpose of each section of the manuscript and the writing tense that should be used. Students were unaware of what to present when writing the introduction, the purpose of the results/discussion sections, and how to report and discuss study results. In the present study, many students were neutral about some survey questions. This might either indicate a lack of knowledge related to survey questions, unclarity of the questions, or lack of students' knowledge about different formatting guidelines related to manuscript sections. In general, knowledge of the manuscript structure was not correlated with the stage of the study, but the proportion of students who were aware of the IMRAD structure was higher in the writing stages compared to the earlier course stage. This indicates a need for continuous training and mentorship at the initial stages of the study.

Although authorship eligibility criteria may vary among different research fields, all journals agree that authorship requires a substantial contribution to concept, design, conduct, analysis, and interpretation of study results. The international committee of medical journal editors (ICMJE) criteria require that authors to contribute significantly to the study concept, design, analysis, or data interpretation AND writing the manuscript or critically reviewing the manuscript AND final approval of the study AND being accountable for all aspects of the study. Our colleagues found that only 27.2% of medical research professors in Jordan were aware of the ICMJE guidelines, nevertheless, 76.8% agreed that all ICMJE criteria must be met for authorship [12]. Unethical authorship practices were reported by 16.5%–31.3% among Jordanian research professors [12]. Although a small percentage of students in this study was aware of the ICMJE criteria, most of the students agreed that authors should meet all the ICMJE criteria to qualify for authorship.

National ethics institutions implement a vigorous peer-review process, attentive validation of statistical analysis, and use specific software to detect plagiarism and image-fraud to produce high-quality manuscripts [17]. For many researchers, scientific misconduct could result from the high ambition to become popular as being involved in international studies, and from interest of financial gain. Scientific misconduct could also be a result of researcher laziness especially in complex studies that need effort and frequent assessment [18]. The drivers of misconduct may be also related to pressure upon researchers to perform [19]. The pressure to publish to fulfill graduation requirements may be a driver of misconduct among graduate students. Advisor–student relations or advisor expectations and organization injustice may lead to misconduct or behavior, particularly for early-career researchers [19]. In the present study, about 50% of students were able to define and distinguish between falsification and fabrication, whereas 75% of them could distinguish plagiarism, suggesting that a considerable proportion is not clear about different types of misconduct. Further, many practices of misconduct were accepted by students such as photo manipulation, citing

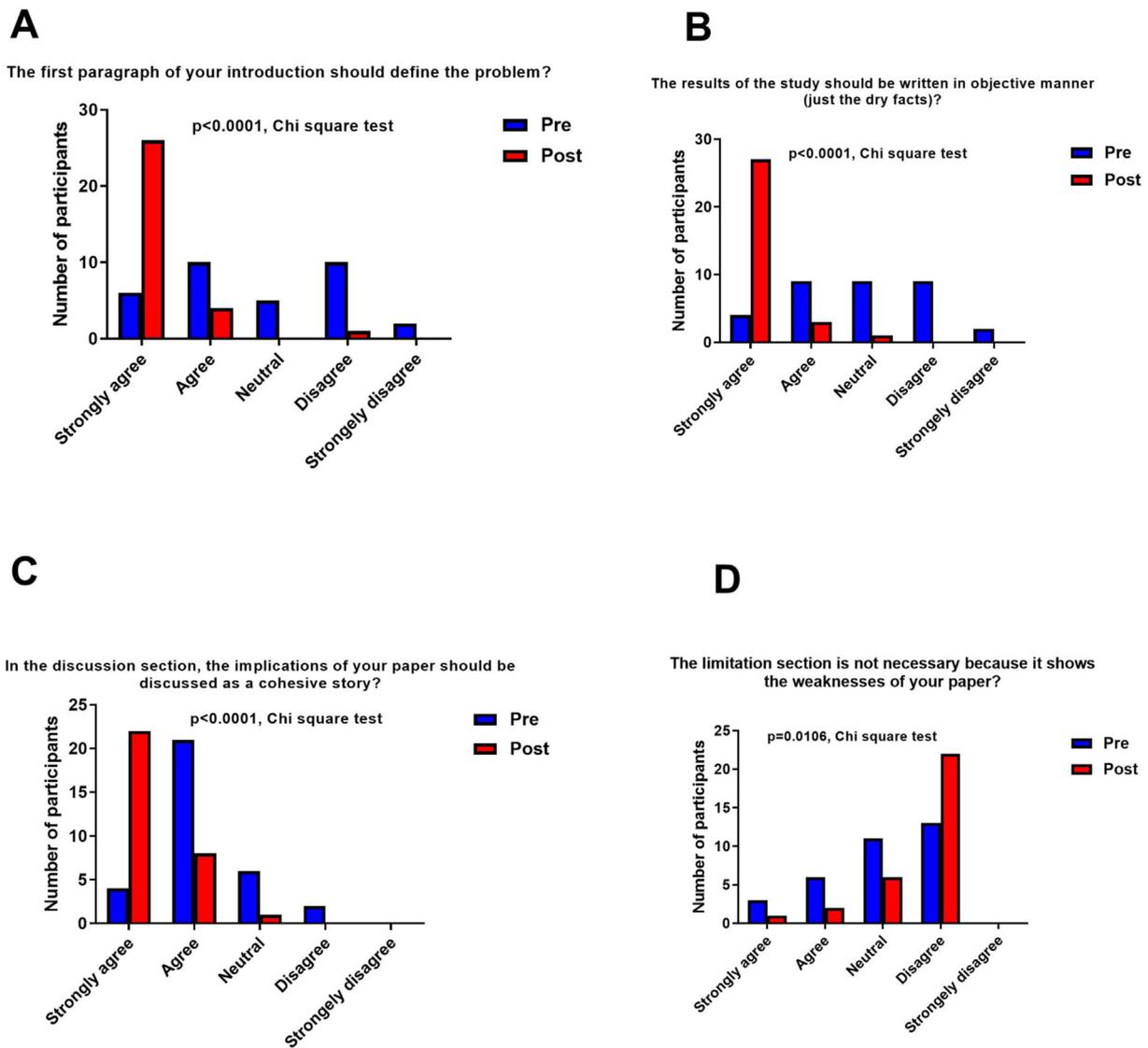


Figure 4. Effectiveness of the workshop in improving awareness of manuscript writing. A–D represents number of participants responded to various study questions related to manuscript structure before and after the training workshop. Number = 285.

without referencing, guest and ghost authorship, indicating a serious threat to scientific integrity. An analysis by the Department of Health and Human Services' Office of Research Integrity and the National Science Foundation revealed that falsification and fabrication are the most frequent practices among medical and graduate students [20].

An analysis of WOS retractions by Chinese researchers between 1997 and 2016 revealed that the number of scientific publications retractions increased in the last 20 years. Plagiarism and faked peer review were the reasons for about 75% of the retractions [21]. A more recent analysis in rheumatology journals revealed that major causes of retractions were redundancy of data, duplication of manuscripts, lack of data reliability, and concerns about authorship [22]. Unfortunately, sometimes the cost of scientific integrity is relatively low [21]. However, researcher reputation, withdrawn funding and retracted publications, and possible loss of employment are not low costs [19]. Scientific misconduct may result in losing the credibility of a study and to ineffective or harmful intervention especially in clinical trials. The impact of misconduct on the affected researchers and the community can be profound. Sponsor cost to investigate fraud and repeated assessment is another consequence [18].

Education in the field of research ethics and integrity is warranted, not only for active researchers, but also for students in the under- and postgraduate programs. In addition, application of severe sanctions

might be used to overcome scientific fraud and misconduct. However, scientific misconduct may be more related to pressures upon researchers to publish rather than by a perceived lack of severe consequences [19]. To secure scientific integrity, several agencies have developed research integrity policies, training modules, guidance handbooks, workshops and improved peer review process to prevent misconduct [20].

Changes in the peer review process and explicit retraction notifications can also help [6]. Relieving the pressure on academics may influence the incidence of scientific misconduct by addressing a need for policy change. There should be a lesser attention to publication rate in grants awarding. Further, institutional rewards could encourage better scientific performance and higher research quality [19].

Several barriers may be encountered by researchers when writing a research manuscript. A study among European researchers working in a large public health institution identified lack of time to write or submit, and limited skills in English and writing as main difficulties when preparing a manuscript for publication [23]. On the other hand, lack of funding support and lack of time for research were reported as major barriers by medical students [6]. Lack of time and encouragement to research were also identified among applied epidemiologists [13]. In the present study, students have raised several barriers to writing a good manuscript for publication. The lack of writing skills, the lack of focused

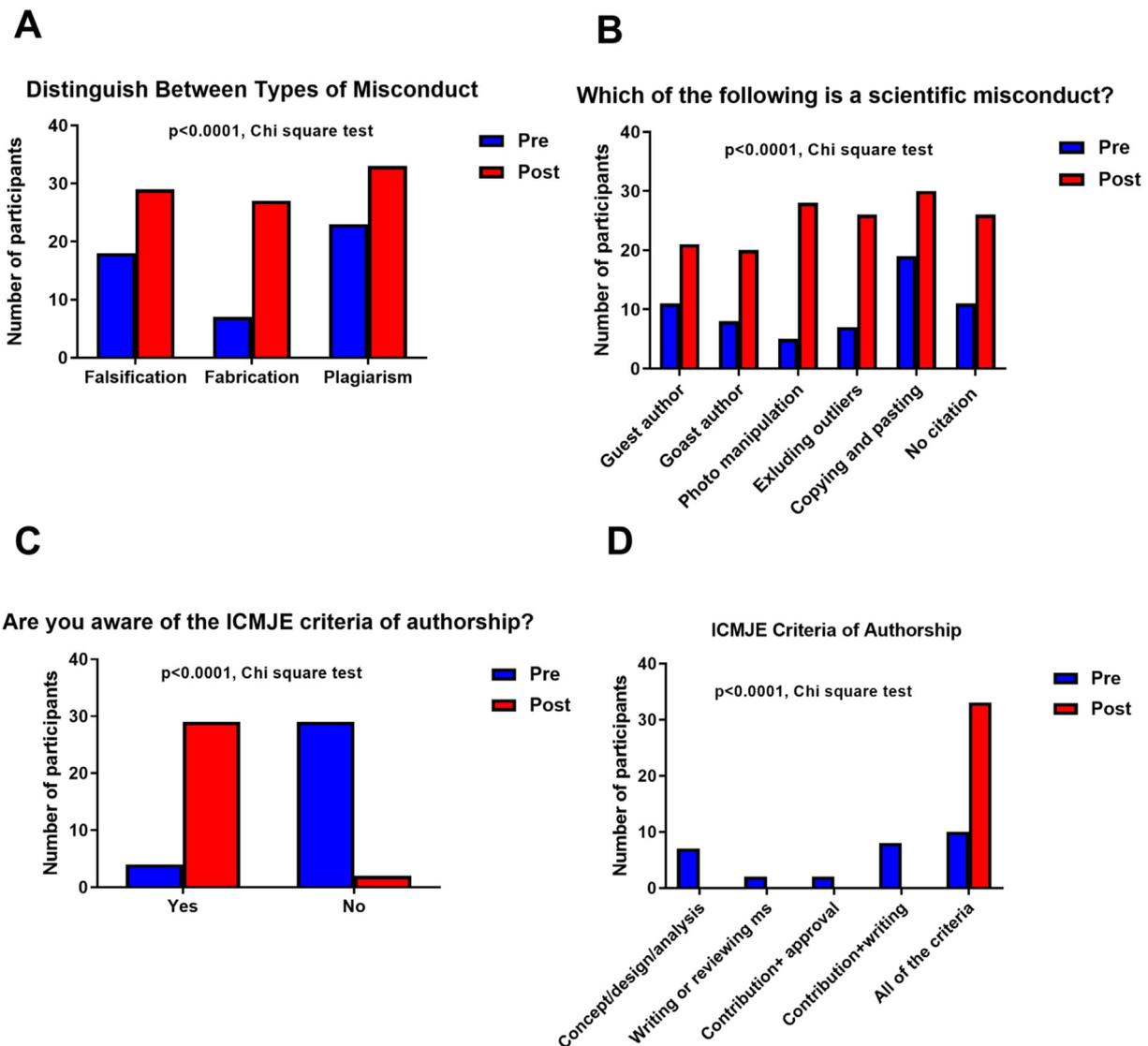


Figure 5. Effectiveness of the workshop in improving awareness of scientific misconduct and authorship guidelines. Represents number of participants responded to various study questions related to scientific misconduct (A–B) and authorship criteria (C–D) before and after the training workshop. Number = 285.

research methodology courses, the lack of research experience during undergraduate study and the lack of training workshops were the most frequently encountered barriers more than the lack of time or incentives, indicating that knowledge and skills in writing among young researcher students are dependent on the availability of training courses and research experiences more than the time.

Training workshops are one of the effective interventions to improve writing skills and facilitate manuscript publication [10]. We have conducted a workshop for graduate students in manuscript writing. The workshop provided graduate students with systematic insights into the key elements of writing an excellent manuscript starting from choosing an appropriate title and ending up with writing the conclusions and references. Important ethical aspects for publication such as authorship, conflict of interest, scientific misconduct, and their consequences were also discussed. The principles for writing clearly and concisely in English were illustrated. The workshop was highly effective in providing a step-by-step guide to write a manuscript with strong interactive focus with participants. The students participated in group discussions and practical exercises. Comparisons between students' responses before and after the workshop revealed the usefulness of the workshops in enhancing the basic knowledge in writing and introducing fundamentals that are essential to effective and ethical manuscript writing.

The Council of State and Territorial Epidemiologists and the Centers for Disease Control and Prevention implemented a weekly intensive training course to enhance the quality of papers submitted by epidemiologists in the health departments. The program has shown the significance of mentorship, case study exercises, and the necessity to resolve structural challenges [24]. Such training programs are recommended in graduate studies and can have a significant impact on the writing quality of manuscripts.

5.1. Educational implications

Our study is the first to evaluate graduate students' knowledge and awareness of manuscript structure and research integrity in Jordan. A relative lack of knowledge about writing manuscript sections and scientific misconduct practices was found, suggesting an immediate need to improve the skills of writing among graduate students in Jordan and other developing countries especially for non-native English speakers. Development of courses on manuscript/thesis writing and research ethics and including them into graduate curricula will help students to gain the foundations in writing. Training workshops to educate and train students on manuscript writing should be performed early at the undergraduate level and can be further firmed during graduate studies before students

get involved in research. Efforts should also be directed toward improving the mentorship through training programs and incentives.

Professional training in scientific misconduct and fraud can prevent unethical practices, produce higher quality studies, and protect students' rights. Policies in scientific misconduct must be developed in research institutions and explained to graduate students. Graduate students should understand that responsible and ethical conduct of research is critical to establish a successful research future.

5.2. Limitations of the study

The study is limited by the small number of students who participated in the workshop as compared to those who completed the baseline questionnaire. The small sample size was due to the limited fund, the limited number of computer devices available on the training site, and the nature of the training interactive workshops that include small group discussions and the need to communicate with all participants. Yet, students from two major universities were included. Few Ph.D. students were included due to the limited number of Ph.D. programs at the included institutes. The present study evaluated students' knowledge from different disciplines and fields using the IMRAD structure for biomedical journals, which is not uniform across different fields and disciplines, yet it is a widely used format, where deviations from this format are usually minimal.

6. Conclusions

There is a lack of knowledge and awareness among graduate students about the structure of manuscript and basic concepts in writing manuscript sections. In addition, there is a lack of awareness of the ethical aspects associated with writing manuscripts including the knowledge of certain types of scientific misconduct and practices. Barriers in manuscript writing included the lack of focused research methodology courses, professional workshops, and constructive mentorship support. Professional workshops are useful to improve students'; knowledge and awareness of manuscript writing and scientific misconduct.

Declarations

Author contribution statement

Fadia Mayyas: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Karem Alzoubi: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

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