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Publication Date

2021-02-19

Peer reviewed

RESEARCH ARTICLE

Assessment of research ethics education offerings of pharmacy master programs in an Arab nation relative to top programs worldwide: A qualitative content analysis

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OPEN ACCESS

Citation: Ahmed WS, Nebeker C (2021) Assessment of research ethics education offerings of pharmacy master programs in an Arab nation relative to top programs worldwide: A qualitative content analysis. PLoS ONE 16(2): e0238755. <https://doi.org/10.1371/journal.pone.0238755>

Editor: Timothy C. Guetterman, University of Michigan, UNITED STATES

Received: August 20, 2020

Accepted: February 4, 2021

Published: February 19, 2021

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Data Availability Statement: All relevant data are within the manuscript and its [Supporting Information](#) files.

Funding: Work on this project was supported by the Research Ethics program in Jordan supported by grant # 5R25TW010026-02. The Research Ethics Program in Jordan had no role in the study design, data collection and analysis, preparation of the manuscript, decision to publish, or funding the publication of this manuscript.

Abstract

The importance of research ethics (RE) training has led academic and funding institutions to require that students, trainees, and faculty obtain such training at various stages of their careers. Despite the increasing awareness of the value RE education offers, this training requirement is absent in Jordan. We aimed to assess RE education offerings of pharmacy master programs in Jordan and compare with the top-ranked pharmacy graduate programs globally. Therefore, a list of universities that offer research-based pharmacy master programs was created. Each program was evaluated for the inclusion of RE education. A qualitative content analysis approach based on inductive reasoning and latent analysis was followed to analyze the data. Results of the study showed a lack of appropriate RE education for graduate-level pharmacy programs in Jordan with only 40% of the programs partially discuss selected topics related to RE. Regarding pharmacy graduate programs globally, 10% offer a standalone RE course, 40% offer some discussions related to RE, another 10% do not offer RE education in any form, and the remaining 40% of the programs were difficult to assess due to lack of sufficient information available online. Based on the findings of this study, training in RE is tends to be lacking in pharmacy graduate programs in Jordan and globally, with a greater lack in Jordan than globally. There is a need to incorporate formal RE education into programs that do not offer this type of instruction. Programs that formally touch on some aspects of RE need to expand the scope of topics to include more RE-related themes. Integrating a standalone RE course into pharmacy graduate programs is highly encouraged.

Introduction

Current research practices in most Arab countries are not governed by nation-wide federal requirements nor do they involve research ethics (RE) training mandates. The situation in the

Competing interests: The authors have declared that no competing interests exist.

Abbreviations: RCR, Responsible Conduct of Research; JU, The University of Jordan; JUST, Jordan University of Science and Technology; MENA, Middle East and North Africa; NIH, National Institute of Health; FIC, Fogarty International Center; MSc, Master of Science; U.S., The United States; QS, Quacquarelli Symonds; ISS, International Student Survey; MERIT, Middle East Research Ethics Training Initiative; NSF, National Science Foundation; NIFA, National Institute of Food and Agriculture; USDA, The United States Department of Agriculture; PHS, Public Health Service; REPJ, Research Ethics Program in Jordan.

country of Jordan is much similar to most Arab countries in that there are no RE education requirements for students and researchers regardless of research funding source [1]. In fact, these educational requirements have become increasingly essential, with federal agencies in countries that leads the scientific research, such as the National Institute of Health (NIH) of the United States (U.S.), implementing such requirements for all individuals involved in research-based activities.

The U.S. NIH requirement for education in the responsible conduct of research (RCR) [2] states that the practice of science with integrity involves “*the awareness and application of established professional norms and ethical principles in the performance of all activities related to scientific research*”. Clearly, ethical behavior in science is valued, and it would follow that RE education is the modality for acculturating scientists to the accepted norms and conventions. In 1989, the NIH announced its first RCR educational requirement for selected NIH trainees [3]. Although increased cases of research misconduct may have triggered the federal requirements for RCR training [4,5], the desire to preserve the integrity of science and to foster a good research practices and a socially responsible community could arguably be another reason [6–10]. The educational requirements were expanded in 1992 and 2000 for the NIH [11,12] and by the Public Health Service (PHS) in 2000 (<http://grants.nih.gov/grants/guide/notice-files/NOT-OD-01-007.html>). The NIH updated its mandate for RCR training in 2009 [2] and, that same year, the National Science Foundation (NSF) introduced an RCR requirement that called for “appropriate training and oversight in the responsible and ethical conduct of research” [13]. In 2010, the NSF RCR requirement went into effect, which required that institutions receiving NSF support have a plan for offering RCR education for all students/trainees (undergraduate, graduate, and postdoctoral) supported on NSF grants. Recently, the National Institute of Food and Agriculture (NIFA) of the United States Department of Agriculture (USDA) incorporated RCR education as an essential requirement for institutions conducting USDA-funded extramural research (<https://nifa.usda.gov/responsible-andethical-conduct-research>).

Unlike the NSF requirement, which only calls for “appropriate training” to be provided to researchers supported by the NSF, the NIH requirement includes detail on what topics to be discussed, as well as expectations on format and frequency of training [5]. The scope of RCR training requirements has varied over different versions of NIH mandates (1989, 1992, 2000, and 2009). In fact, the U.S. office of research integrity (ORI) identified nine core areas which need to be addressed in an RCR course. This was followed by a Delphi consensus panel report which identified 53 topics in seven core areas to be included in RE teaching [14]. Some RCR topics have evolved over time, while others were newly introduced in later versions of the federal requirements. Generally, accepted topics include conflict of interest and bias, research subject protections, data management, authorship and publication ethics, and social responsibilities [5].

As noted, increased cases of research misconduct in the 1980’s led to a special congressional task force to define the scope of research misconduct [4,5] and, eventually, federal requirements for RCR training. How the training requirements were implemented by institutions bound by these new training requirements varied considerably across the U.S. [14–16]. In addition to the variability in RCR instruction by institution, inconsistencies in what instructors thought they were to accomplish specific to goals were also common [17] making evaluation of the efficacy of RCR training challenging [6]. A range of suggested goals are available in the RCR literature [14,17].

While the federal agencies mandate institutions to provide RCR training to comply with training requirements; increasingly, institutions offer RCR training regardless of funding requirements [5]. In addition to U.S. institutions promoting RE training to foster an ethically

responsible research environment, the NIH Fogarty International Center (FIC) also supports proactive RE education internationally. For example, FIC has funded RE education in Latin America, Africa and in the Middle East. The notion that most Middle East countries, including Jordan, lack RE training mandates [1], and the fact that many collaboration research projects in these countries are funded by U.S. agencies [18] could provide a reasonable motive behind FIC funds outside of the U.S.

Although lacks federal RE training mandates, Jordan is still considered one of the most academically established countries in the Middle East and North Africa (MENA) region with progressive research agendas. Jordan also has a well-established pharmaceutical industry that exports several products globally. This pharmaceutical sector relies heavily on contract research organizations for drug development and post-marketing studies [1]. In fact, The Jordanian pharmaceutical industry is the second largest export industry in the country, exporting around 80 percent of the production to more than 60 countries worldwide [19]. A prime example of this pharmaceutical industry would be “Hikma Pharmaceuticals”, which has more than 700 branded and generic products distributed worldwide (<https://www.hikma.com/>). Indeed, these pharmaceutical companies rely, on the larger part, on pharmacy graduates that shape the research and development in these companies. As a result, Jordan has been part of two major initiatives of RE training, both of which are supported by grants from the NIH FIC:

- Middle East RE Training Initiative (MERETI) initiated in 2005 and offers training in RE to individuals (mid-level and senior professionals) from the Middle East. (<https://www.mereti-network.net/>; <https://www.fic.nih.gov/Grants/Search/Pages/Bioethics-1R25TW007090-01.aspx>)
- The RE education program in Jordan (REPJ) which started in 2015, and targets junior researchers from the MENA region. (<https://jordanrcrprogram.com/about/>; <https://www.fic.nih.gov/Grants/Search/Pages/bioethics-TW010026.aspx>)

Graduate masters-level pharmacy programs in Jordan generally require that students complete an independent research project. Given this expectation and the potential value of RCR education in preparing researchers to design and implement their research ethically and responsibly, we sought to assess the extent to which RE education was included in graduate pharmacy programs in Jordan. To see how Jordan pharmacy programs compared globally with respect to RCR offerings, we then sought to investigate the offerings at the top ranked graduate pharmacy programs.

Materials and methods

Data collection in Jordan

Data collection for this part involved several steps. In the beginning, websites of all Jordanian universities with a pharmacy school or department were reviewed to identify schools/departments offering one or more masters-level programs in pharmacy. Then, we searched through each program’s description to document programs requiring students to carry out an independent research project to satisfy completion requirements along with the coursework requirement. In case the program’s description was not available online, it was retrieved from the corresponding pharmacy school/department by a direct in-person visit. Next, we searched through the description of individual courses in a program to identify courses that offer RE education. The purpose was to identify whether programs that included an expectation to conduct research also provided RE instruction. The website search was conducted in English language. Based on this search, a spreadsheet was compiled (S1 Table) documenting courses with

Table 1. Keywords related to research ethics (RE) that were highlighted from course descriptions.

Keywords			
Approvals	Authorship	Benefit-risk ratio	Ethics
Consent	Ethical aspects	Ethical challenges	Ethical committees
Ethical considerations	Ethical frameworks	Ethical issues	Ethical requirements
Ethics approval	Ethics board	Ethics committee	Ethics submissions
Important issues	Issues	Medical ethics	Multi-disciplinary team
Problems	Problems in pharmacology research	Regulatory	Regulatory committees
Regulatory requirements	Research approaches	Research ethics	Research misconduct
Risk assessment	Risk management	Risk minimization	Safety board
Team approach	Special problems	Research problems	Regulatory frameworks
Obligations	Expertise	Ethical concerns	Conflict of interest

<https://doi.org/10.1371/journal.pone.0238755.t001>

dedicated or imbedded material related to RE by examining the list of course, their titles, and their descriptions. RE instruction was determined by searching for keywords related to RE in the course description (Table 1). For courses that contained one or more keywords related to RE in their description, in order to determine the scope of RE topics covered, the entire course content was then retrieved by a direct in-person visit to the corresponding pharmacy school/department. Fig 1 summarizes the data collection process in Jordan.

Data collected during the review process were entered into a spreadsheet that included: 1- name of the university and the pharmacy master program offered, 2- name of all courses, core (obligatory) and elective (optional), offering RE instruction, 3- course description, 4- keywords related to RE used in the course description, 5- whether RE are the main and only focus of the course or an imbedded material (i.e. RE are mentioned or discussed in the course but are not the only focus of the course), and 6- RE related topics covered in the course (S1 Table).

Data collection beyond Jordan

The next step was to compare graduate RE educational offerings in Jordan with that of pharmacy graduate programs offered globally. For this part, the data collection was based entirely on information available online. Since our data collection took place during July–August 2017, we therefore used the Quacquarelli Symonds (QS) World University Ranking (2017) to search for the top 10 universities worldwide by subject of pharmacy and pharmacology (<https://www.topuniversities.com/university-rankings/university-subject-rankings/2017/pharmacy-pharmacology>). The QS World University Ranking, published by Quacquarelli Symonds (QS) Limited, is one of the most popular and reputable rankings in the educational market [20].

After the list of the top 10 universities was created, websites of these universities were then reviewed for pharmacy master programs that have mixed coursework and research-project completion requirements. Individual programs were then screened by reviewing the course description of individual courses in the programs for core or elective courses that fully or partly discuss RE related issues. The website search was conducted in English language. The data collection process of global programs is summarized in Fig 2.

Based on this search, data were collected and recorded in a spreadsheet and included: 1- name and rank of the university, 2- name of the master program offered, 3- the school or department offering the program, 4- course title, 5- whether the course is core or elective, 6- the course description, 7- keywords related to RE used in the course description, 8- whether the course offers RE instruction as the only focus or as one component of the course, and 9- the course website address (the website address of the program was used whenever no specific

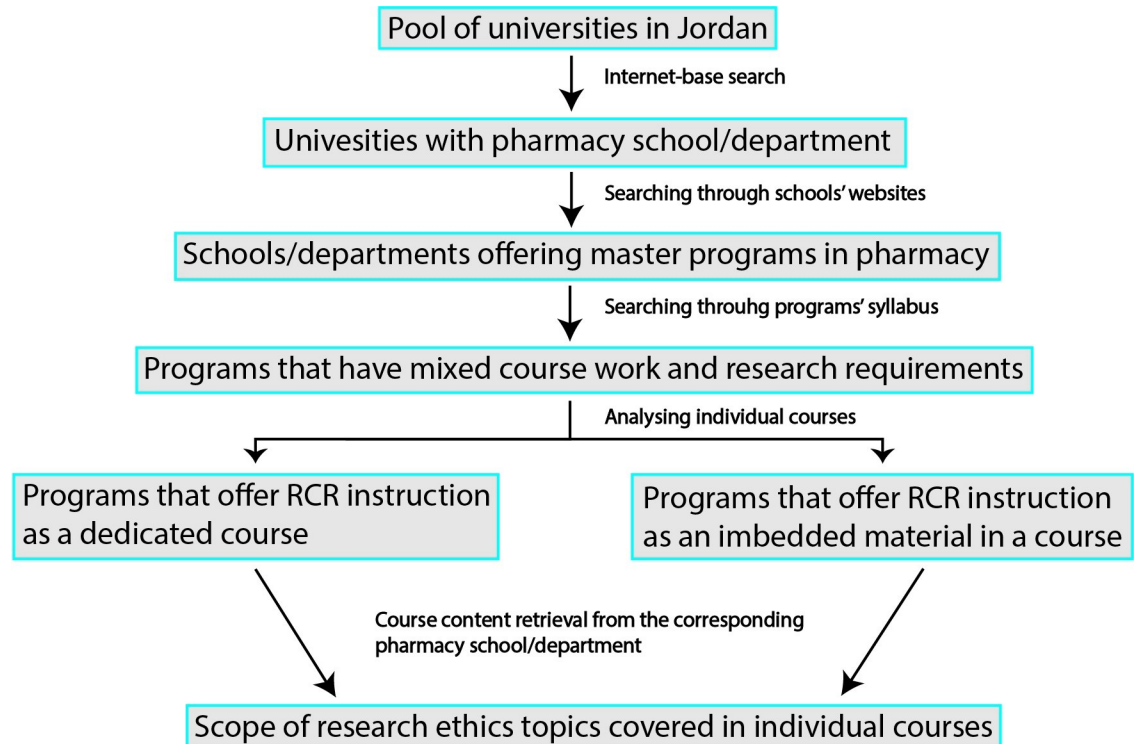


Fig 1. Stepwise data collection approach from universities in Jordan.

<https://doi.org/10.1371/journal.pone.0238755.g001>

website address is available for the course) [S2 Table]. All information was retrieved from official online sources with no direct or indirect contact with the universities or their schools.

Data analysis

The study aim was to qualify and quantify RE instruction offered by pharmacy master programs in Jordan and compare the results with the top 10 universities by subject of pharmacy and pharmacology. Our first sample included pharmacy master programs with mixed

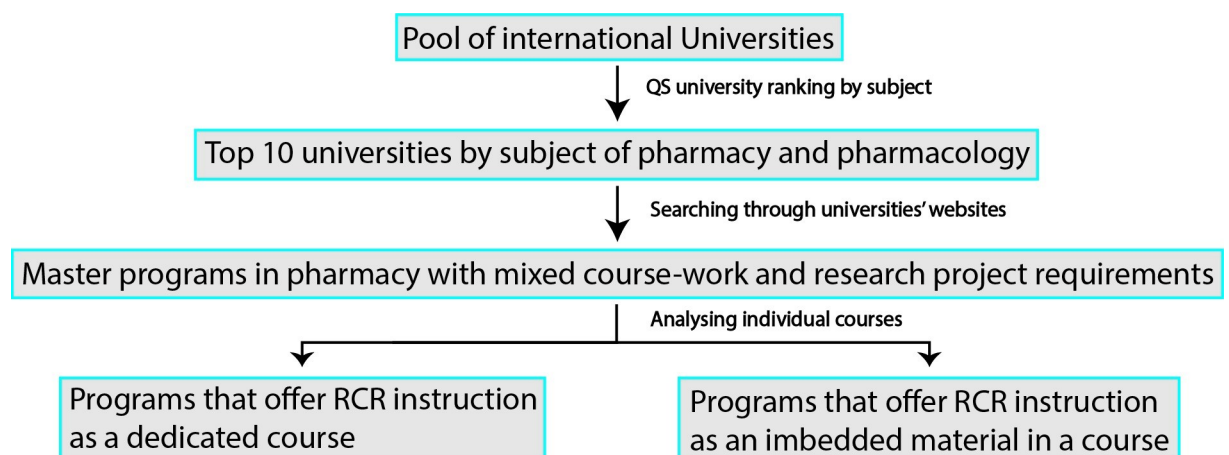


Fig 2. Stepwise data collection approach from top 10 universities globally.

<https://doi.org/10.1371/journal.pone.0238755.g002>

coursework and research completion requirements that are offered by universities in Jordan. Our second sample included master programs offered by the top 10 universities by subject of pharmacy and pharmacology. Individual courses in the programs served as units of analysis, courses descriptions served as meaning units, and keywords observations from written course description texts served as condensed meaning units. A qualitative content analysis, based on inductive reasoning was applied [21]. Several other studies utilized content analysis to assess major text books and other educational resources for RCR content [22,23]. We followed a latent analysis approach, as some of the keywords we extracted from the description texts to reflect RE instruction may not explicitly refer to RE in an obvious manner, rather it was our interpretation of these keywords through which we tried to seek their underlying content reference.

In order to conceptualize on the collected data, the data analysis process consisted of the following four steps: the decontextualization, the recontextualization, the categorization and theming, and the compilation (Fig 3). The decontextualization step entails reading through texts to identify meaning units, which are broken down into condensed meaning units, and creating a coding list. Recontextualization includes comparing all meaning units from the previous step with the original text to check and make sure that all aspects of the relevant content have been captured and coded properly. Categorization involves grouping the created codes into subcategories and categories that are homogenous on the interior but heterogenous on the exterior, that are then appropriately themed. The compilation is the last step through which the results are compiled into meaningful conclusions.

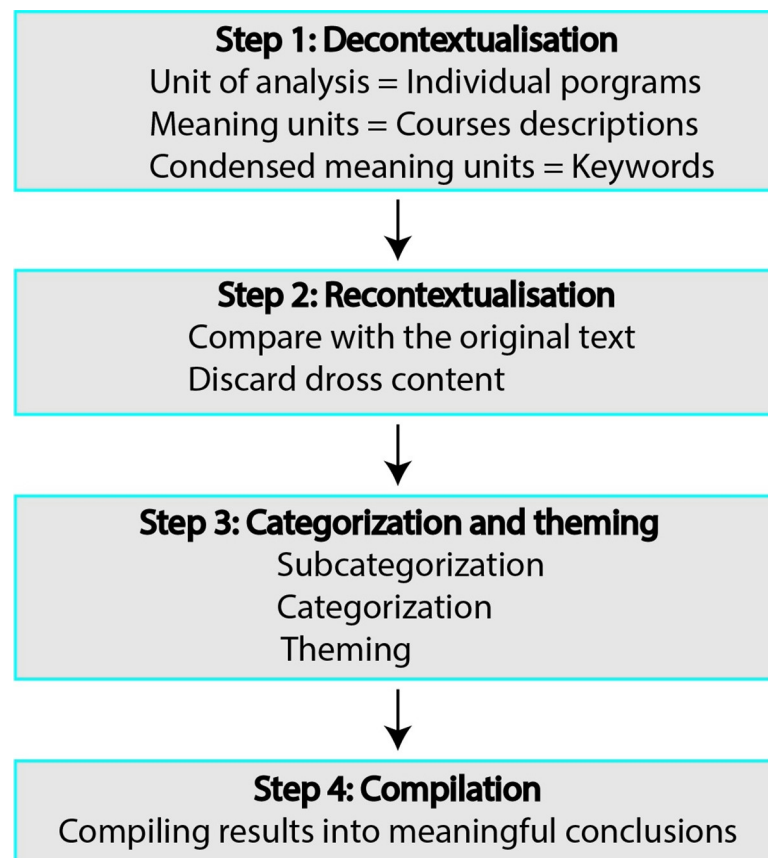


Fig 3. Overview of the data analysis process.

<https://doi.org/10.1371/journal.pone.0238755.g003>

Step 1. Decontextualisation: For each course, the course description served as the meaning unit, keywords related to RE served as condensed meaning unit. A coding list was created for each course as follows:

- i. If keywords were observed in the description and the course title was indicative of a course specialized in RE (e.g. “research ethics” course, “responsible conduct of research” course), we coded “Yes—dedicated” for that course.
- ii. If the description included keywords related to RE, but the course title and description were indicative of other contents unrelated to RE, we coded “Yes–imbedded” for that course.
- iii. If the course did not include any keywords related to RE, we coded “No” for that course.

Step 2. Recontextualisation: The condensed meaning units were put back and compared with the original description text to make sure all relevant keywords related to RE have been captured. Then, all other text words in the description were considered dross and excluded from further analysis.

Step 3. Categorization and theming:

- i. Subcategories
 - a. Core and elective courses coded as “Yes–dedicated”.
 - b. Core and elective courses coded as “Yes–imbedded”.
 - c. Core and elective courses coded as “No”.
- ii. Categories
 - a. Programs that included subcategory (a) or (b).
 - b. Programs that included subcategory (a).
 - c. Programs that included subcategory (b) but not (a).
 - d. Programs that included subcategory (c) but not (a) or (b).
 - e. Programs that did not include any of the subcategories (a), (b), or (c).
- iii. Themes

Category (a) was themed as programs that offer some form of RE education in one or more of their courses.

Category (b) was themed as programs that offer one or more dedicated RE course.

Category (c) was themed as programs that offer RE education imbedded into one or more of their courses.

Category (d) was themed as programs that do not offer RE education in any form.

Category (e) was themed as programs that were difficult to assess for RE education offerings due to lack of sufficient information online.

Step 4. Compilation: results were compiled and used to draw meaningful conclusions as discussed later in this article.

Results

RCR in Jordan

Our search revealed 19 universities in Jordan that have a pharmacy school or department with only 7 of those offering mixed coursework and research based master's degree in pharmacy (Table 2). The total number of pharmacy master programs offered in the 7 universities was 10 (Table 3). All 10 programs stated a completion requirement to conduct a research project. With the exception of the University of Jordan (JU) and Jordan University of Science and Technology (JUST), all other universities that offer pharmacy master's degree programs reported offering neither a dedicated course on RE nor RE-integrated formal discussions within an existing course. The school of pharmacy at the University of Jordan (JU) offers a Master of Science (MSc) Clinical Pharmacy program with one obligatory course in "research methodology" that includes RE instruction as one component of the course. The imbedded RE material is focused on research involving humans with emphasis on informed consent and role of an institutional review board, authorship and publication ethics, conflict of interest, data confidentiality, and research misconduct (fabrication, falsification, and plagiarism) [S1 Table]. Most of these topics align with the NIH federal requirements for RCR. The master program in Pharmaceutical Sciences offered by the same school, however, does not discuss RE in any of its courses, despite having a research project completion mandate. The school of pharmacy at Jordan University of Science and Technology (JUST) offers three master programs, each with an obligatory "research methodology" course, which includes some discussion of ethical issues related to research. The same topics were covered in the three courses with a focus on human research, animal research, and research misconduct, all of which align with the NIH mandates (Tables 3 and S1).

Table 2. List of Universities with pharmacy schools/departments in Jordan.

#	Name of University	Private University	City	Pharmacy master program(s) with thesis track
1	Jordan University of Science and Technology	No	Irbid	I. Clinical Pharmacy II. Pharmaceutical Technology III. Medicinal chemistry and Pharmacognosy
2	University of Jordan	No	Amman	I. Clinical Pharmacy II. Pharmaceutical Sciences
3	Yarmouk University	No	Irbid	None
4	Hashemite University	No	Zarqa	None
5	Zarqa University	Yes	Zarqa	None
6	Balqa Applied University		Irbid	None
7	Philadelphia University at Jordan	Yes	Jarash	None
8	Mutah University	No	Karak	None
9	German Jordanian University	No	Amman	None
10	Applied Science University	Yes	Amman	Pharmaceutical Sciences
11	Al Ahliyya Amman University	Yes	Balqa	Pharmaceutical Studies
12	Middle East University Jordan	Yes	Amman	None
13	Al Zaytoonah University	Yes	Amman	Pharmaceutical Sciences
14	University of Petra	Yes	Amman	Pharmaceutical Sciences
15	Jerash Private University	Yes	Jarash	None
16	Amman Arab University	Yes	Amman	None
17	American University of Madaba	Yes	Madaba	None
18	Al Isra University Amman	Yes	Amman	Pharmacy
19	Jadara University	Yes	Irbid	None

<https://doi.org/10.1371/journal.pone.0238755.t002>

Table 3. Pharmacy master programs by mixed coursework/research offered by Jordanian universities and their RE education offerings.

Pharmacy master program	RE courses offered			N/A
	No	Yes		
		Dedicated (C, E)	Integrated (C, E)	
<i>The University of Jordan</i>				
Clinical Pharmacy	-	0	1 (C)	-
Pharmaceutical Sciences	✓	0	0	-
<i>Jordan university of Science and Technology</i>				
Clinical Pharmacy	-	0	1 (C)	-
Pharmaceutical Technology	-	0	1 (C)	-
Medicinal Chemistry and pharmacognosy	-	0	1 (C)	-
<i>Applied Science University</i>				
Pharmaceutical Studies	✓	0	0	-
<i>Al Ahliyya Amman University</i>				
Pharmaceutical Studies	✓	0	0	-
<i>Al Zaytoonah University</i>				
Pharmaceutical Sciences	✓	0	0	-
<i>University of Petra</i>				
Pharmaceutical Sciences	✓	0	0	-
<i>Al Isra University Amman</i>				
Pharmacy	✓	0	0	-

Dedicated: Number of standalone RE courses offered by a program; Integrated: Number of courses in a program that integrate RE discussions; N/A: No enough information to assess RE education offerings; C: Core course; E: Elective course.

<https://doi.org/10.1371/journal.pone.0238755.t003>

RCR beyond Jordan-globally

According to the information available online, the total number of pharmacy master programs with mixed course-load and research requirement offered by the top 10 universities by subject of pharmacy and pharmacology is 20 programs. Of the 20 programs, two programs (10%) offer a dedicated research ethics course, eight programs (40%) offer RE education material that is integrated into one or more of the program's courses, and two programs (10%) contain neither a dedicated course of RE nor a course that integrates RE material. Another eight programs (40%) were difficult to assess for RE instruction offerings because the course description of these programs was either missing or incomplete. (Tables 4 and S2).

Discussion

This qualitative study revealed a dearth of RE education for master's level pharmacy programs in Jordan. None of the programs offered a standalone RE course. A minority (less than half) of programs offered in Jordan integrated partial RE instruction into one of their core courses with a focus on human RE and research misconduct. Although these programs discuss RE themes in their courses that are aligned with what the NIH require in its mandate, these themes still do not capture the scope of topics required in the NIH guidelines [2] as many were missing and not discussed. The core components of RE training as indicated by the 2009 NIH mandates and the U.S. ORI include: mentor-mentee responsibilities, research misconduct, research protections of humans and animals, conflict of interest and bias, ethics of collaborative research, data management, publication and authorship ethics, peer-review, and social responsibilities [2,14].

Table 4. Pharmacy master programs by mixed coursework/research offered by the top 10 universities ranked by subject of pharmacy and pharmacology (QS ranking, 2017) and their RE education offerings. Universities are listed based on their ranking in the top 10 list (highest to lowest).

Pharmacy master program	RE courses offered			N/A
	No	Yes		
		Dedicated (C, E)	Integrated (C, E)	
<i>University of Harvard (no programs are offered)</i>				
<i>University of Monash</i>				
Master of Clinical Pharmacy	-	0	1 (C), 1 (E)	-
<i>University of Cambridge (no mixed programs are offered)</i>				
<i>University of Oxford</i>				
Pharmacology	-	-	-	✓
<i>University of California, San Francisco</i>				
Clinical Research	-	1 (C)	0	-
<i>University of Nottingham</i>				
Drug Discovery and Pharmaceutical Sciences	-	-	-	✓
<i>King's College London</i>				
Clinical Pharmacology	-	0	4 (C)	-
Drug Development Science	-	0	4 (C)	-
Pharmacology	-	0	2 (C)	-
Biopharmaceuticals	-	-	-	✓
Pharmaceutical Analysis and Quality Control	-	-	-	✓
Pharmaceutical Technology	✓	-	-	-
Pharmacy Practice	✓	-	-	-
<i>University College London</i>				
Medicinal Natural Products and Phytochemistry	-	-	-	✓
Pharmaceutics	-	0	1 (C)	-
Drug Discovery and Development	-	0	2 (C)	-
Drug Discovery and Pharma Management	-	0	2 (C)	-
Pharmaceutical Formulation and Entrepreneurship	-	0	1 (E)	-
Clinical Pharmacy, International Practice and Policy	-	-	-	✓
Drug Sciences	-	-	-	✓
<i>The University of Tokyo</i>				
Pharmaceutical Sciences	-	-	-	✓
<i>Karolinska Institute</i>				
Pharmaceutical Medicine	-	1 (C)	0	-

Dedicated: Number of standalone RE courses offered by a program; Integrated: Number of courses in a program that integrate RE discussions; N/A: No enough information to assess RE education offerings; C: Core course; E: Elective course.

<https://doi.org/10.1371/journal.pone.0238755.t004>

To see how Jordan pharmacy programs compared globally with respect to RCR offerings, we sought to investigate the offerings at the top ranked graduate pharmacy schools worldwide, which include universities from Asia, Europe, and North America. Globally, assessing RE instruction offerings was more challenging as it was entirely based on information available from online official sources, which most of the time were either incomplete or entirely missing. For global programs that we indicated to offer RE education, it was difficult to identify the topics of RE they discuss based solely on keywords from their course descriptions. Out of the 20 global programs offered, we were able to assess the RE instruction offerings of only 12 (60%). Two out of the twelve programs offered a standalone RE core course (2/12, 17%), two did not offer any form of RE instruction (2/12, 17%), and eight offered RE education incorporated

Table 5. Summary and comparison between RE education offerings in Jordan and globally.

Theme	Jordan N (%)	Top 10 Universities Globally N (%)
Total number of pharmacy master programs.	10	20
Number of programs offering one or more dedicated RE course(s).	0	2 (10)
Total number of programs offering RE education imbedded in one or more of their course(s).	4 (40)	8 (40)
Number of programs offering some form of RE education in one or more of their course(s).	4 (40)	10 (50)
Number of programs not offering RE education in any form.	6 (60)	2 (10)
Number of programs that were difficult to assess for RE education offerings due to lack of sufficient information online.	0	8 (40)

<https://doi.org/10.1371/journal.pone.0238755.t005>

into one or more courses (8/12, 67%). The ultimate can be further classified into programs that integrate RE education into only one core or elective course (2/12, 17%) or into more than one course (6/12, 50%). Based on these findings, one could conclude that formal RE education tends to be lacking globally as well. However, the lack is greater in Jordan than globally (Table 5).

Jordan, although considered a developing country, is one of the more academically established countries in the MENA region with progressive research agendas that involve international collaborations. As inter-disciplinary research and collaboration between industrialized and developing countries grows bigger, there emerges the need for capacity building in the developing countries with respect to the RCR as well as the ethical review process [24–26]. Numerous deficiencies were previously reported to exist in the ethics guidelines and regulations of countries in low and middle income countries in the Middle East and Africa [27,28]. A study by Hayder et al. under the former National Bioethics Advisory Commission surveyed health researchers in developing countries to explore issues related to the IRB review. About half of the respondents (44%) disclosed that their projects were not reviewed by an IRB review committee in their countries, of which one-third of these projects were funded by a U.S. funding agency [18].

Systematic education or training in RE prior to enrolment in pharmacy graduate education in Jordan is unlikely, as undergraduate pharmacy programs in Jordan do not have a research project completion requirement [29]. Thus, one could assume that pharmacy graduate students lack appropriate training and preparation in the systematic RE training most needed at the beginning of the postgraduate program. Although Jordan's "Accreditation and Quality Assurance Commission for Higher Education Institutions" oversees that "minimal requirements" are being fulfilled in order to establish a pharmacy master's program, RE education does not seem to be part of these "minimal requirements". For that reason, integrating RE education into postgraduate pharmacy programs in Jordan is highly encouraged. In fact, there is a support for this type of training even among health sciences faculty members in Jordan [30]. In this case, pharmacy graduate programs in JUST and JU could serve as a role model in that they contain RE educational material integrated into one or more of their core courses, although integrating a rather "dedicated" RE course into those master programs is highly encouraged, as it was previously reported that RCR programs conducted separately from the standard curricula were more effective than those imbedded into existing modules [31].

Responsible conduct of research education seems to be of great importance in responding to research misconduct and promoting positive attitudes in research. A multi-institutional survey in the U.S., which involved graduate students among the surveyed participants who were enrolled in RCR courses, reported a wide range of plausible outcomes for RCR courses, which

had greater impact on knowledge more than fostering skills or attitudes [32]. Several other studies identified favorable outcomes of RCR education in improving knowledge, attitudes, ethical decision making, self-reported behavior, and sense-making skills [6,33–35], although these improvements might have been described as being modest [6].

It is worth mentioning that despite the NIH training mandates, several studies failed to provide great evidence of its effectiveness [6,31,36,37]. This could be, in part, due to the fact that RE education goals may not be clearly stated nor explicitly specified at the outset of the RCR programs [17]. Therefore, achievable goals need to be clearly articulated at the outset. Several recommendations were addressed in the Delphi consensus panel report regarding the RCR goals and contents and how to adapt the RCR programs to fit the trainees needs [14]. Kalichman and Plemmons have also recommended potential goals for RCR education [17]. Another influencing factors for the effectiveness of RCR educations may include lack of consensus about the contents of RCR education across different institutions and programs [17,38,39] leading to high variability of development and implementation of RCR instructions [33,34,38]. Furthermore, low level of institutional support [15] and uncoordinated initiatives [4] may also have a negative impact on the outcomes of RCR education. In addition to specifying clear goals for RCR education, several other strategies have been proposed in the literature to overcome the obstacles mitigating the outcomes of RCR training, including competence-based development of RE instructions [40,41], applying research-based narratives assignment [42,43], careful consideration of instructional designs [36,44], applying the principles of andragogy [45] and leaning theories [44,46] to RCR education, improving mentoring strategies of RCR educators [10,47–50], and using situational factors in real research environment rather than classrooms experience [36,51,52], as well as online teaching using internet-based courses [53–56].

Limitations

There are limitations to this research that can be addressed and mitigated with further research. One major limitation was the lack of available information online for some of the global programs. In addition, identification of RE education material for global programs was based solely on keywords we highlighted from the course description to reflect RE instruction (Table 1). There is the possibility that these keywords may refer to topics unrelated to RE (for instance key words such as issues, problems, regulatory, etc.). As such, our model of data collection and analysis, may lead to an overestimation of RE education status rather than an underestimation. For the same reason, little can be inferred about the actual content and the range of RCR topics and core areas covered in the global programs. Moreover, we only included master programs that have mixed course-load and research mandates. Programs that were completed entirely by coursework were excluded as they do not require students to carry-out research. Programs entirely focused on research were excluded as well, as there was not clear information available online regarding the structure of these programs. Besides, this study focused on “formal education/training”, whereas informal/extracurricular training may occur within master programs that required students to conduct research and not as part of the formal coursework. Using ranking systems other than the QS World University Ranking (2017) may lead to results that are slightly different, as the top 10 universities by subject of pharmacy and pharmacology are slightly different depending on the ranking system used.

It is worth mentioning that data collection from local programs in Jordan was more feasible compared to the global programs as it was easier to reach out to schools within Jordan when needed. For global programs, we did not try to reach out to schools. Rather, we used information that was available online.

Conclusions

Training in the RCR for pharmacy graduate students involved in academic research is lacking to higher extent in Jordan than globally as indicated in this qualitative study. Integrating a standalone RCR courses into pharmacy graduate programs and widening the scope of core RCR topics discussed in existing RCR-based courses is highly encouraged. On the other hand, newly established RCR training programs in the MENA region such as the “Research Ethics Program in Jordan; REPJ” which was established in 2015 and is supported by the NIH Fogarty International Center to target young researchers from the MENA region, could play an important role in building capacity among the next generation of scientists. The RCR-Jordan fellows in return would play a pivotal role in raising awareness towards the importance of RCR education and fostering a research culture in which the RCR principles are expected and accepted.

Supporting information

S1 Table. Research ethics education offerings of pharmacy master programs in Jordan.

Listed are universities that offer master programs with mixed coursework and research requirements.

(PDF)

S2 Table. Research ethics education offerings of pharmacy master programs in the top 10 universities globally by subject of pharmacy and pharmacology. Listed are all top 10 universities and all pharmacy master programs they offer by mixed coursework and research requirements.

(PDF)

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References

1. REPJ. Introduction: Responsible Conduct of Research 2019 [cited 2019 February 4]. Available from: <https://jordanrcrprogram.com/welcome-to-the-program/>.
2. NIH. Update on the requirement for instruction in the Responsible Conduct of Research announced November 24, 2009. Available online at <http://grants.nih.gov/grants/guide/notice-files/NOT-OD-10-019.html>.
3. NIH. Requirement for programs on the responsible conduct of research in National Research Service Award Institutional Training Programs. NIH guide for grants and contracts. 1989; 18(45), 1. Available online at http://grants.nih.gov/grants/guide/historical/1989_12_22_Vol_18_No_45.pdf.
4. Steneck N, Bulger R. The history, purpose, and future of instruction in the responsible conduct of research. *Acad Med.* 2007; 82(9):829. <https://doi.org/10.1097/ACM.0b013e31812f7d4d> PMID: 17726385

5. Kalichman M. A Brief History of RCR Education. *Account Res.* 2013; 20(5–6):380. <https://doi.org/10.1080/08989621.2013.822260> PMID: 24028484
6. Antes AL, Murphy ST, Waples EP, Mumford MD, Brown RP, Connelly S, et al. A Meta-Analysis of Ethics Instruction Effectiveness in the Sciences. *Ethics Behav.* 2009; 19(5):379. <https://doi.org/10.1080/10508420903035380> PMID: 19838311
7. Albertsa B, Kirschnerb MW, Tilghmanc S, Varmusd H. Rescuing US biomedical research from its systemic flaws. *Proc Natl Acad Sci.* 2014; 111(16):5773–7. <https://doi.org/10.1073/pnas.1404402111> PMID: 24733905
8. Kalichman M. Responsible Conduct of Research Education (What, Why, and Does It Work?). *Acad Med.* 2016; 91(12):e10. <https://doi.org/10.1097/ACM.0000000000001442> PMID: 27749309
9. National Academies of Sciences, Engineering, and Medicine. *Fostering integrity in research.* Medicine NAOSEa, editor. Washington, DC: The National Academies Press.; 2017.
10. Kalichman M, Plemmons D. Intervention to Promote Responsible Conduct of Research Mentoring. *Sci Eng Ethics.* 2018; 24(2):699. <https://doi.org/10.1007/s11948-017-9929-8> PMID: 28608033
11. NIH. Reminder and update: requirement for instruction in the responsible conduct of research in national research service award institutional training grants. NIH guide for grants and contracts. 1992; 21(43). Available online at <http://grants.nih.gov/grants/guide/notice-files/not92-236.html>.
12. NIH. PHS Policy on Instruction in the Responsible Conduct of Research (RCR) Announced December 5, 2000. Available online at <http://grants.nih.gov/grants/guide/notice-files/NOT-OD-01-007.html>.
13. NSF. Responsible Conduct of Research. Proposal and Award Policies and Procedures Guide. Part II—Award and Administration Guidelines. 2009; pp. IV–3. Available online at www.nsf.gov/pubs/policydocs/pappguide/nsf10_1/nsf10_1.pdf.
14. DuBois JM, Dueker JM. Teaching and assessing the responsible conduct of research: A Delphi consensus panel report. *J Res Adm.* 2009; 40(1):49. PMID: 22500145
15. Kalichman M. Responding to challenges in educating for the responsible conduct of research. *Acad Med.* 2007; 82(9):870. <https://doi.org/10.1097/ACM.0b013e31812f77fe> PMID: 17726394
16. Bernabe RD, van Thiel GJ, van Delden JJ. What do international ethics guidelines say in terms of the scope of medical research ethics? *BMC Med Ethics.* 2016; 17. <https://doi.org/10.1186/s12910-016-0106-4> PMID: 27117273
17. Kalichman M, Plemmons D. Reported goals for responsible conduct of research courses. *Acad Med.* 2007; 82(9):846. <https://doi.org/10.1097/ACM.0b013e31812f78bf> PMID: 17726389
18. Hyder A, Wali S, Khan A, Teoh N, Kass N, Dawson L. Ethical review of health research: a perspective from developing country researchers. *J Med Ethics.* 2004; 30(1):68. <https://doi.org/10.1136/jme.2002.001933> PMID: 14872079
19. Sweis RJ, Al-Ghawi HJ, AlSaleh NA-A, Zu'bi M, Obeidat BY. Benchmarking of TQM: the case of Hikma Pharmaceuticals company. *Benchmarking: An International Journal.* 2015.
20. Rodionov DG, Rudskaia IA, Kushneva OA. The importance of the university world rankings in the context of globalization. *Life Sci J.* 2014; 11(10):442–6.
21. Bengtsson M. How to plan and perform a qualitative study using content analysis. *NursingPlus Open.* 2016; 2:8–14.
22. Heitman E, Bulger R. Assessing the educational literature in the responsible conduct of research for core content. *Account Res.* 2005; 12(3):207. <https://doi.org/10.1080/08989620500217420> PMID: 16634172
23. Kon AA, Schilling DA, Heitman E, Steneck NH, DuBois JM. Content Analysis of Major Textbooks and Online Resources Used in Responsible Conduct of Research Instruction. *Am J Bioethics.* 2011; 2(1):42. <https://doi.org/10.1080/21507716.2011.564263> PMID: 21766046
24. Parker M, Kingori P. Good and Bad Research Collaborations: Researchers' Views on Science and Ethics in Global Health Research. *PLoS ONE.* 2016; 11(10). <https://doi.org/10.1371/journal.pone.0163579> PMID: 27737006
25. Mathur A, Lean SF, Maun C, Walker N, Cano A, Wood ME. Research ethics in inter-and multi-disciplinary teams: Differences in disciplinary interpretations. *PLoS ONE.* 2019; 14(11). <https://doi.org/10.1371/journal.pone.0225837> PMID: 31774867
26. Corbie-Smith G, Wynn M, Richmond A, Rennie S, Green M, Hoover SM, et al. Stakeholder-driven, consensus development methods to design an ethical framework and guidelines for engaged research. *PLoS ONE.* 2018; 13(6). <https://doi.org/10.1371/journal.pone.0199451> PMID: 29928015
27. Alahmad G, Al-Jumah M, Dierickx K. Review of national research ethics regulations and guidelines in Middle Eastern Arab countries. *BMC Med Ethics.* 2012; 13:34. <https://doi.org/10.1186/1472-6939-13-34> PMID: 23234422

28. De Visser A, Hatfield J, Ellaway R, Buchner D, Seni J, Arubaku W, et al. Global health electives: Ethical engagement in building global health capacity. *Med Teach*. 2020;1. <https://doi.org/10.1080/0142159X.2020.1724920> PMID: 32083958
29. Al-Wazaify M, Matowe L, Albsoul-Younes A, Al-Omran OA. Pharmacy Education in Jordan, Saudi Arabia, and Kuwait. *Am J Pharm Educ* 2006; 70(1). <https://doi.org/10.5688/aj700118> PMID: 17136159
30. Tarboush NA, Alkayed Z, Alzoubi KH, Al-Delaimy WK. The understanding of research ethics at health sciences schools in Jordan: a cross-sectional study. *BMC Med Educ*. 2020; 20. <https://doi.org/10.1186/s12909-020-02040-5> PMID: 32316962
31. Antes AL, Wang X, Mumford MD, Brown RP, Connelly S, Devenport LD. Evaluating the effects that existing instruction on responsible conduct of research has on ethical decision making. *Acad Med*. 2010; 85(3):519. <https://doi.org/10.1097/ACM.0b013e3181cd1cc5> PMID: 20182131
32. Plemmons D, Brody S, Kalichman M. Student perceptions of the effectiveness of education in the responsible conduct of research. *Sci Eng Ethics*. 2006; 12(3):571. <https://doi.org/10.1007/s11948-006-0055-2> PMID: 16909159
33. Mulhearn T, Steele L, Watts L, Medeiros K, Mumford M, Connelly S. Review of Instructional Approaches in Ethics Education. *Science and engineering ethics*. 2017; 23(3):883. <https://doi.org/10.1007/s11948-016-9803-0> PMID: 27387564
34. Watts LL, Medeiros KE, Mulhearn TJ, Steele LM, Connelly S, Mumford MD. Are ethics training programs improving? A meta-analytic review of past and present ethics instruction in the sciences. *Ethics Behav*. 2017; 27(5):351–84. <https://doi.org/10.1080/10508422.2016.1182025> PMID: 30740008
35. AlMahmoud T, Hashim MJ, Elzubeir MA, Branicki F. Ethics teaching in a medical education environment: preferences for diversity of learning and assessment methods. *Med Educ Online*. 2017; 22(1).
36. Anderson M, Horn A, Risbey K, Ronning E, De Vries R, Martinson B. What do mentoring and training in the responsible conduct of research have to do with scientists' misbehavior? Findings from a National Survey of NIH-funded scientists. *Acad Med*. 2007; 82(9):853. <https://doi.org/10.1097/ACM.0b013e31812f764c> PMID: 17726390
37. Powell S, Allison M, Kalichman M. Effectiveness of a responsible conduct of research course: a preliminary study. *Sci Eng Ethics*. 2007; 13(2):249. <https://doi.org/10.1007/s11948-007-9012-y> PMID: 17717736
38. DuBois JM, Schilling DA, Heitman E, Steneck NH, Kon AA. Instruction in the Responsible Conduct of Research: An Inventory of Programs and Materials within CTSA's. *Clin Transl Sci*. 2010; 3(3):109. <https://doi.org/10.1111/j.1752-8062.2010.00193.x> PMID: 20590680
39. Nicholls SG, Hayes TP, Brehaut JC, McDonald M, Weijer C, Saginur R, et al. A Scoping Review of Empirical Research Relating to Quality and Effectiveness of Research Ethics Review. *PLoS ONE*. 2015; 10(7). <https://doi.org/10.1371/journal.pone.0133639> PMID: 26225553
40. Schultes M, Aijaz M, Klug J, Fixsen D. Competences for implementation science: what trainees need to learn and where they learn it. *Advances in health sciences education: theory and practice*. 2020.
41. Dahnke M. Utilizing codes of ethics in health professions education. *Adv Health Sci Educ Theory Pract*. 2014; 19(4):611. <https://doi.org/10.1007/s10459-013-9484-2> PMID: 24449124
42. Lencucha R. A research-based narrative assignment for global health education. *Adv Health Sci Educ Theory Pract*. 2014; 19(1):129. <https://doi.org/10.1007/s10459-013-9446-8> PMID: 23377611
43. Kinsella E, Phelan S, Park LA, Mom V. An investigation of students' perceptions of ethical practice: engaging a reflective dialogue about ethics education in the health professions. *Adv Health Sci Educ Theory Pract*. 2015; 20(3):781. <https://doi.org/10.1007/s10459-014-9566-9> PMID: 25354661
44. McGee R, Almquist J, Keller J, Jacobsen S. Teaching and learning responsible research conduct: influences of prior experiences on acceptance of new ideas. *Account Res*. 2008; 15(1):30. <https://doi.org/10.1080/08989620701783758> PMID: 18298028
45. Nebeker C. A proposal for thinking strategically about ethics education: applying the principles of andragogy to enhance teaching and learning about responsible conduct of research (RCR). *J Philos Sci Law*. 2014; 14(1):32–46.
46. Nebeker C. Smart teaching matters! Applying the research on learning to teaching RCR. *J microbiol Biol Educ*. 2014; 15(2):88. <https://doi.org/10.1128/jmbe.v15i2.849> PMID: 25574253
47. Whitbeck C. Group mentoring to foster the responsible conduct of research. *Sci Eng Ethics*. 2001; 7(4):541. <https://doi.org/10.1007/s11948-001-0012-z> PMID: 11697010
48. Faden R, Klag M, Kass N, Krag S. On the importance of research ethics and mentoring. *Am J Bioethics*. 2002; 2(4):50. <https://doi.org/10.1162/152651602320957565> PMID: 12762925
49. Peiffer A, Laurienti P, Hugenschmidt C. Fostering a culture of responsible lab conduct. *Science*. 2008; 322(5905):1186. <https://doi.org/10.1126/science.322.5905.1186b> PMID: 19023060

50. Plemmons D, Kalichman M. Mentoring for Responsible Research: The Creation of a Curriculum for Faculty to Teach RCR in the Research Environment. *Sci Eng Ethics*. 2018; 24(1):207. <https://doi.org/10.1007/s11948-017-9897-z> PMID: 28281158
51. Anderson MS, Louis KS. The graduate student experience and subscription to the norms of science. *Res High Educ*. 1994; 35(3):273–99.
52. Thayer EK, Rathkey D, Miller MF, Palmer R, Mejicano GC, Pusic M, et al. Applying the institutional review board data repository approach to manage ethical considerations in evaluating and studying medical education. *Med Educ Online*. 2016;21. <https://doi.org/10.3402/meo.v21.32021> PMID: 27443407
53. Bird S, Sieber J. Teaching ethics in science and engineering: effective online education. *Sci Eng Ethics*. 2005; 11(3):323. <https://doi.org/10.1007/s11948-005-0001-8> PMID: 16190273
54. Halkoaho A, Matveinen M, Leinonen V, Luoto K, Keränen T. Education of research ethics for clinical investigators with Moodle tool. *BMC Med Ethics*. 2013; 14:53. <https://doi.org/10.1186/1472-6939-14-53> PMID: 24330709
55. Ogunrin OA, Ogundiran TO, Adebamowo C. Development and pilot testing of an online module for ethics education based on the Nigerian National Code for Health Research Ethics. *BMC Med Ethics*. 2013; 14:1. <https://doi.org/10.1186/1472-6939-14-1> PMID: 23281968
56. Sawarynski KE, Baxa DM. Utilization of an online module bank for a research training curriculum: development, implementation, evolution, evaluation, and lessons learned. *Med Educ Online*. 2019; 24(1).