Brief Report

Online training clinical pharmaceutical apprenticeship course for reducing medication errors of community pharmacists

Alaa Abou Halawah[1,2]*, Mayssoon Dashash[1,3], Adnan Baddour[1,4]

[1]Medical Education Master Program Meded, Syrian Virtual University SVU, Damascus, Syria.
[2]Faculty of Pharmacy, International University of Science and Technology IUST, Daraa, Syria.
[3]Department of Pediatric Dentistry, Faculty of Dentistry, Damascus University Damascus, Syria.
[4]Department of Pharmacy, Faculty of Pharmacy, University of Kalamoon, Damascus, Syria.

Article info

Article history:
Received 14 Aug. 2023
Accepted 17 Dec. 2023
Published 10 May. 2024

***Corresponding author:**
Alaa Abou Halawah, Medical Education Master Program Meded, Syrian virtual university SVU, Damascus, Syria.
Email: alaa_halaweh@yahoo.com

How to cite this article:
Halawah AA, Dashash M, Baddour A. Online training clinical pharmaceutical apprenticeship course for reducing medication errors of community pharmacists. J Med Edu Dev. 2024; 17(54): 139-148.

Abstract

Background & Objective: Medication errors are among the most serious problems affecting health systems worldwide. Pharmacists have an essential role in detecting and reducing these errors. So they should have the vital competencies.

Materials & Methods: An online course was created and uploaded to the Syrian Virtual University platform. After participants electronic registered, the course was presented in 3 modules, each lasting 7 days, making the total course was 21 days long. Subsequently, a quasi-experimental study with a pretest-posttest design was conducted on 11 students. Data for both tests and questionnaire at the end of the course were collected using Google Forms™ links to evaluate students' responses and learning. The data were analyzed using SPSS software.

Results: Before the intervention, the mean and standard deviations of 11 participants' results were 55.27 ± 15.61, compared to 81.36 ± 14.63 after the intervention. There is a significant difference between the average grades before and after implementing the course ($p = 0.003$). There were no statistically significant differences between the average grades of students after taking the online course and their academic year ($p = 0.273$) or gender ($p = 0.059$). The overall evaluation of the course was positive.

Conclusion: The course has been efficient and positively received by students with its significant impact on developing students' competencies that will allow them to work professionally after graduation and reduce medication errors.

Keywords: E-learning, competency developmen, medication errors, pharmaceutical education, healthcare quality improvement

Introduction

Medication errors are global challenging preventable issues that can occur throughout the medication-use system when the drug is being prepared, dispensed, or when it is given or taken by the patient (1). The U.S. Food and Drug Administration (FDA) has indicated that more than 100,000 reports related to medication errors are submitted from hospitals, and pharmacies, which can raise mortality, disability, and hospitalization ratios or may cause life-threatening situations for patients (2). The global cost associated with medication errors has reached about US$42 billion yearly nearly 1% of total global health expenditure (3). Medication errors cause at least one death every day and hurt around 1.3 million people yearly, around 7,000 to 9,000 people die due to medication errors in the United States of America alone. While low- and middle-income countries are estimated to have similar rates of medication-related errors to high-income countries, unfortunately, medication errors in Middle Eastern countries particularly Syria still remain obscure and insufficient (4, 5). Community pharmacists play a critical role in patient safety in the medication dispensing process (6). One study found that patients visited a community-based pharmacy 35 times per year, compared to a primary care physician, which occurs on average, 4 times per year (7). This frequent contact with patients

[DOI: 10.61186/edcj.17.54.139]

raises the responsibility of Community pharmacists as primary healthcare providers in the healthcare system. Their success depends primarily on the retention of knowledge and skills (8, 9), which begins at essential educational levels to foster developing competence. For Inadequate competencies among Community pharmacists, inadequate competencies stemming from insufficient training and the need for additional professional education before graduation can increase the likelihood of medication errors, posing greater risks to patients.

Various global studies have demonstrated substantial reductions in the overall incidence of medication errors through pharmaceutical educational interventions (10, 11, 12. 13). However, in Syria, there is currently a lack of studies and documented data in this area. The pharmacy curriculum in Syrian universities is a 5-year semester-based undergraduate program, leading to a Bachelor Of Pharmacy (BPharm) degree, commences with basic academic courses in the first two years that cover fundamental sciences including (biology, physics, biostatistics,etc.) in conjunction with their practical components conducted the laboratories. Subsequently, delve into the courses related to specialized pharmaceutical sciences such as (pharmacognosy, pharmacology, therapeutics, clinical biochemistry, etc.) over the following three years. Pharmaceutical apprenticeship is one of the most important courses. Students can register for it commencing in the third year as practical training in the community pharmacies alongside classroom lectures. This course is mandatory in the Syrian pharmacy faculties and with success being a basic requirement for obtaining a bachelor's degree in pharmacy (BPharm), accredited by the Ministry of Higher Education (14). Where the students should practice under the supervision of qualified pharmacists before graduation. However, several pharmacies due to the Syrian crisis have been closed. Moreover, some students had to change their places of residence. Consequently, they encountered several difficulties in finding qualified guiding pharmacists who can systematically supervise and train them (9). As a result, this results in poor pharmaceutical competencies which contribute to medication error rates, which this can be prevented by bridging knowledge gaps and enhancing competencies before practice, with formal systematic educational intervention (10, 11).

In this regard, the E-learning approach can improve the knowledge of pharmacy students. It can offer several valuable strategies to advance professional learning (15). Several studies support the effectiveness of online education in enhancing the knowledge and skills of pharmacy students globally across various pharmaceutical topics and contexts (16).

On the other hand, in the Arab World particularly in Syria and other politically unstable regions, studies about the effectiveness of e-learning in pharmacy are still limited. Some studies have demonstrated its positive effect on pharmaceutical knowledge enhancement, despite the many challenges faced, there is still a need for recommendations for future research in this field (17, 18).

In this context, online education on clinical pharmaceutical apprenticeship would be of great importance to pharmacists to equip them with adequate training to prevent medical errors. It holds significant importance for pharmacists. For example, enhancing knowledge about common medical error scenarios through the presentation of real pharmaceutical practice can help pharmacists avoid errors such as adverse drug interactions, prescription errors, administration errors, and transcribing errors. Therefore, this study aimed to evaluate the effectiveness of introducing clinical pharmaceutical apprenticeship as an online course for a group of undergraduate pharmacy students over a 21-day period. The study assessed its impact on their knowledge levels through pre- and post-intervention tests, as well as gathering their feedback through a questionnaire.

Material & methods

Design and setting(s)

This study was a quasi-experimental study employing pre-test and post-test design conducted totally online for a nonrandomized group of undergraduate pharmacy students enrolled in various Syrian pharmacy colleges, during the academic year 2021-2022.

Participants and sampling

The sample consisted of undergraduate pharmacy students from various faculties, using a convenience sampling method. Inclusion criteria required students to be in their third or fourth year of their undergraduate program and had completed the pharmaceutical apprenticeship course offered in their respective faculties. These eligible students were encouraged to voluntarily register for the online course. Conversely, students in earlier years were not included because they did not meet the academic prerequisites for the course. The study was conducted on students who met the criteria and were accepted (females = 9, males = 2), Their personal information was collected and sent to the

[DOI: 10.61186/edcj.17.54.139]

program coordinator, and then they were provided with registration access accounts to the Learning Management System (LMS) platform on the Syrian Virtual University (SVU) website, where the course was hosted https://lms.svuonline.org/course/view.php?id=2095

Tools/Instruments

Informed consent was obtained from registered students, A basic instructional video was prepared and distributed to all registered students at the start of the first module. The content was divided into three modules, developed through focused discussions with faculty tutors as arbitrators to decide the main topics as an E-content package in five phases: Analysis, Design, Development, Implementation, and Evaluation (ADDIE model) is considered the most effective model for designing online educational courses and training programs professionally in an academic way (19).

The content was presented sequentially, each module was of Seven days duration, and the entire online course was completed in twenty-one days (Figure 1).

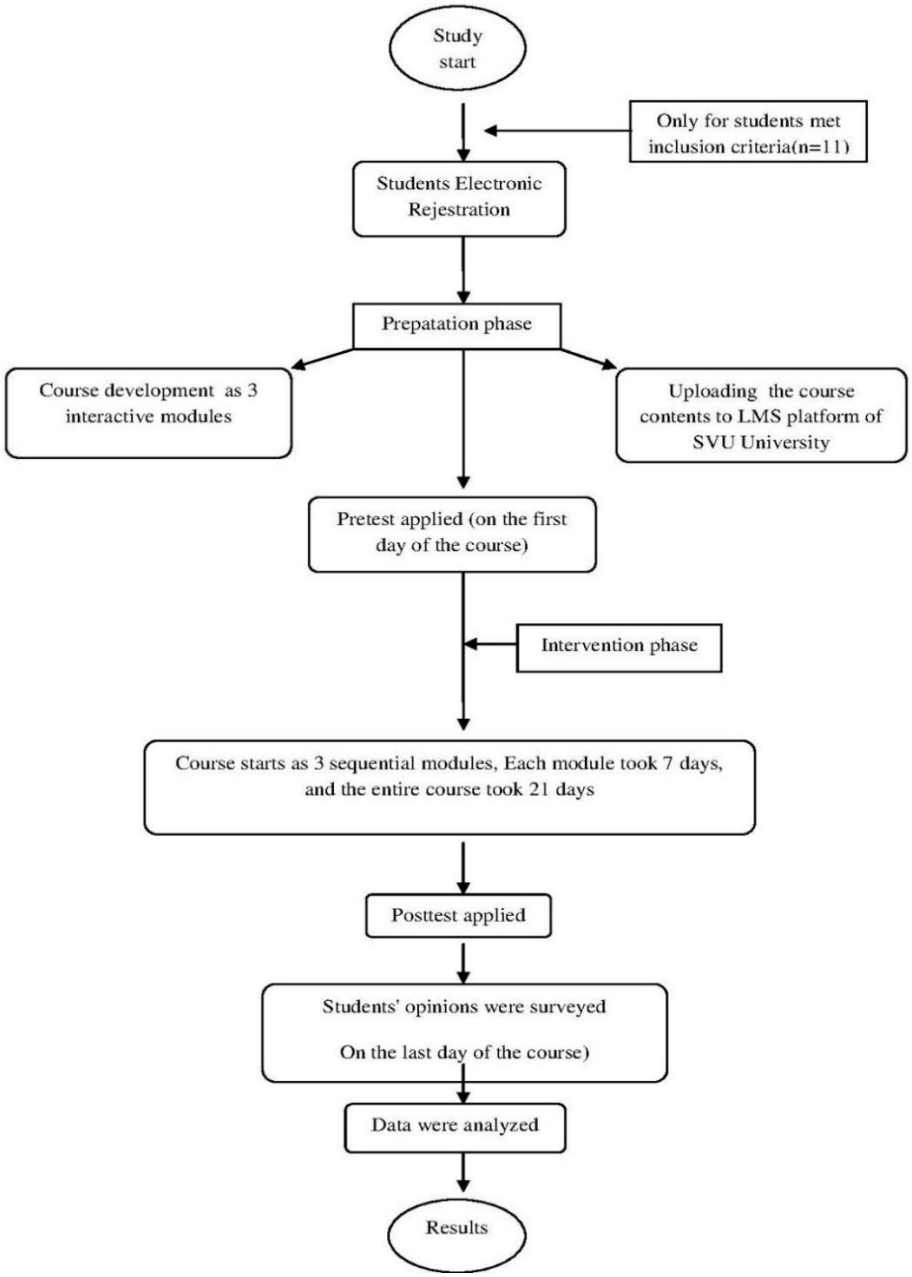

Figure1. Research design of quasi-experimental study pretest-posttest single group

[DOI: 10.61186/edcj.17.54.139]

Focused Group Discussions (FGDs) were conducted continuously during the course period, using a WhatsApp group.

Three modules' essential lines were developed based on focused discussions with faculty tutors, acting as arbitrators to decide the main topics as an E-content package in five phases: Analysis, design, development, implementation, and evaluation (ADDIE model). Intended Learning Outcomes (ILOs) were set for each module based on Bloom's taxonomy framework gradient from simple to complex.

The modules were designed as interactive presentations using Microsoft Office PowerPoint 2007, that were supported with interactive educational tools. The content of the course was validated by the supervisor Prof. Adnan Badour with two other professors (Dr. Samar Alzeer and Dr.Shaden Haddad) who are faculty members at Syrian pharmacy colleges and serve as content experts, before it was uploaded to the learning management system, according to the essential information from Syrian pharmacy curricula, and their practical experiences.

Data collection methods

Pre-test and post-test were designed and prepared in Arabic language using Google Forms™ links for data collection, to assess the knowledge level of students before starting the course, and to determine whether it had improved after finishing it. The pre-test was administered immediately before the commencement of the first module. Each module spanned a duration of 7 days, and the entire course, comprising all 3 modules, and was completed within 21 days.

It consisted of thirty-one Multiple-Choice Questions (MCQ) linked to the learning objectives of each module. The post-test consisted of the same questions with the same distribution and conducted immediately after finishing the last module (with a 21-day gap between two tests). The maximum possible score for each test was 100. An English version of the test questions is available in additional file 1.

At the end of the course, a feedback questionnaire was created using Google form and distributed to participants through personalized links, for participants to provide an overall course evaluation. The questionnaire was designed using the five-point Likert scale; with 1 indicating strongly disagree, 2 for disagree, 3 for neither agree nor disagree, 4 for Agree, 5 for strongly agree, and it included 29 items divided into four sections. Content and test validity were checked and examined using experts' opinions regarding fluent writing, and understandable words.

The reliability of the overall questionnaire was verified, using Cronbach's alpha coefficient, where values ranging between 0 and 1, and the acceptable threshold in social studies is 60%. By applying the data obtained, its value was 0.72, resulting in a validity coefficient of 0.85" for clarity which indicates that the questionnaire is reliable, valid, and honest.

An English version copy of the questionnaire statements is available in additional file 2.

Data analysis

Only results from participants who completed all modules and took both pre- and post tests were considered. Data were transferred from Google Form™ to Excel format.

The Statistical Package of Social Science software (IBM SPSS statistic program version 25) was used to analyze the final data. Descriptive statistics, such as mean and Standard Deviation (SD), were used to analyze the study outcomes. The Wilcoxon and Mann-Whitney tests were employed to compare the changes in pre- and post intervention scores with a significance level of ($p < 0.05$). These tests are typically used for small data sets rather than large ones and are valuable for comparing related samples before and after intervention (20). A five-point Likert scale was adopted and set as a questionnaire to evaluate students' satisfaction. The mean was calculated for each statement out of 5, and for each section of the evaluation, then for the total questionnaire. Mean values and ranges were also used to provide verbal expression for the mean responses (strongly disagree=1.00-1.8, disagree = 1.81-2.60, not sure = 2.61-3.40, agree = 3.41-4.20, strongly agree = 4.21-5).

Results

Eleven participants in total (9 Females with a ratio of 82%, and 2 males with a ratio of 18%) were met the criteria and invited voluntarily to be part of the study. All participants were from Syrian pharmacy faculties; 5 participants (45.5%) from third-year students, and 6 (54.5%) from fourth-year students.

The results indicate a significant enhancement in participants' cognitive gains. Prior to the online course, the mean and standard deviations were 55.27 ± 15.61, whereas, after the educational intervention, it was 81.36 ± 14.63.

The Wilcoxon test showed a significant difference between the average grades before and after

[DOI: 10.61186/edcj.17.54.139]

implementing the course (P = 0.003, P < 0.05). When assessing the effectiveness of the online course based on academic year, there were no significant statistical differences between the average scores of students after completing the course and their academic year (P = 0.273). Similarly, no significant statistical differences were observed when comparing the average scores of students after competing the online course based on gender (P = 0.059). These findings are presented in Table1 and Table 2.

All participants completed the feedback questionnaire, resulting in 100% response rate. The overall evaluation of the course was positive as indicated in Table 3. Some participants encountered challenges related to the availability of basic requirements, with a mean score of 2.09 for this statement. Additionally, they suggested increasing the amount of information and topics provided in the course, with a mean score of 4.18 for this statement.

Discussion

The e-learning approach has been a necessity recently, it is considered a fast, reliable, and effective way for learning (21), and it has increased significantly during the COVID-19 pandemic to continue teaching-learning activities in a safe way (22).

Such crises affect medical students' practical training and their required competencies, which may reduce the opportunity to work professionally in the healthcare system later (23) and raise medication error ratios, which can be mitigated at the pharmacist level by intervention with e-learning courses (24), pharmacists can primarily intercept and report these errors before they affect patients (25), particularly for those with limited opportunities to receive training during their undergraduate level, especially in a low-resource and unstable environment like Syrian. so this course tried to come up with a feasible effective way to provide additional learning opportunities (26).

This study found that the online course effectively increased students' knowledge, skills, and confidence. The results showed that the cognitive gain increased, and average test scores increased significantly after course participation.

These findings are consistent with the study of Ruehter and colleagues (27), and Battaglia and colleagues (28), who agreed with the use of technology and e-learning as effective way to facilitate and increase the knowledge and confidence of pharmacy students.

Additional studies have also discussed the effectiveness of e-learning in the pharmaceutical field.

Crouch (29) indicated that online introductory presentations in cardiology pharmacotherapy have improved student preparation, enhanced their knowledge about cardiovascular drugs, and were pleased with the course.

Legris and colleagues (30) designed the study as a Web-based training program on drug-related problems in chronic kidney disease. They found that the program improved participants' knowledge and skills with acceptable result in their clinical practices.

This result also agreed with Bykhovsky and colleagues (31) used online videos as e-learning tools, to increase pharmacy students' information about folic acid and related neural tube disorders, the results confirmed the significant role of e-learning in enhancing the knowledge level of students.

All of the previous studies with different medical topics have reported, according to their results, the positive impact of online courses on pharmacy students' knowledge, and this is compatible with the results of the current study.

Otherwise, the study of Almaghaslah et al (32) has shown that the majority of pharmacy student respondents preferred face-to-face lectures in class over online modules, indicating less enthusiasm among pharmacy students for online learning methods within the pharmacy curriculum. Therefore, it is recommended and encouraged to find other studies on the impact of e-learning on the educational attainment of pharmacy students and their preferences about it. Additionally, Freeman and co-workers (33) found that a majority of students preferred traditional lectures within classrooms compared to e-learning modules. It is noteworthy that a positive impact on knowledge gain was manifested across students' results.

On the contrary, through surveying participants' opinions in the current study, the preference for the online course was obvious, and their attitudes towards it were positive. The mean of the total questionnaire was 4.35 on a 5-point Likert scale.

Table 1. The comparison between students cogantive gain before and after the intervention

Results of participents	n	Mean ± SD	Minimum	Maximum
Before the intervention	11	55.27 ± 15.61	33	79
After the intervention	11	81.36 ± 14.63	49	93
*p-value	0.003			

Note: *Wilcoxon Signed Ranks Test was used, $p < 0.05$
Abreviations: n, number of participants; SD, Standard division

[DOI: 10.61186/edcj.17.54.139]

Table 2. Tests results before and after application of the online course with (post-test Statistics according to variable: Academic year and gender)

Results	The test applied	The test result	p-value	α -value
Results of pre and post-intervention	Wilcoxon	-2.936	0.003	
Results of pre and post-intervention (according to study year)	Mann-Whitney	9.00	0.273	α = 0.05
Results of pre and post-intervention(according to gender)	Mann-Whitney	1.00	0.059	

Table 3. Statistical analysis of course evaluation

A. Statements evaluation			
Statements number	Mean	S.D*	Expressions
1.1	4.36	0.51	Strongly agree
1.2	4.27	0.47	Strongly agree
1.3	4.27	0.47	Strongly agree
1.4	4.36	0.51	Strongly agree
1.5	4.54	0.52	Strongly agree
1.6	4.27	0.47	Strongly agree
2.1	4.73	0.47	Strongly agree
2.2	4.55	0.52	Strongly agree
2.3	4.18	0.41	Agree
2.4	4.45	0.52	Strongly agree
2.5	4.27	0.47	Strongly agree
2.6	4.64	0.52	Strongly agree
2.7	4.18	0.41	Agree
2.8	4.45	0.52	Strongly agree
2.9	4.45	0.52	Strongly agree
3.1	2.09	1.04	Disagree
3.2	4.09	0.302	Agree
3.3	4.36	0.51	Strongly agree
3.4	4.73	0.47	Strongly agree
3.5	4.55	0.52	Strongly agree
3.6	4.82	0.41	Strongly agree
3.7	4.82	0.41	Strongly agree
3.8	4.18	0.41	Agree
3.9	4.45	0.52	Strongly agree
4.1	4.36	0.51	Strongly agree
4.2	4.55	0.52	Strongly agree
4.3	4.09	0.3	Agree
4.4	4.64	0.51	Strongly agree
4.5	4.55	0.52	Strongly agree
B. Section evaluation			
Section number	Mean	S.D	Expressions
1	4.33	0.24	Strongly agree
2	4.43	0.22	Strongly agree
3	4.23	0.22	Strongly agree
4	4.44	0.34	Strongly agree
C. Total questionnaire evaluation			
Statements 1.1 to 4.5	4.35	0.18	Strongly agree

Abbreviation: SD, Standard division

In the present study, the assessment method was mainly Multiple-Choice Question (MCQ) tests; it is recommended that the methods of assessment should be extended to include more assessment methods to assess higher thinking and other interpersonal skills (34). The current study, an assignment has already been set, but it was optional because of the limited time for completing the course.

In addition, participants had been carefully selected, and statistical tests for both their results and their opinions surveys were significant. However, the presented findings can be considered preliminary due to

[DOI: 10.61186/edcj.17.54.139]

the small sample size and short course duration. Future research will consider these limitations by increasing the sample size and increasing the course duration to ascertain the findings.

This work has created new learning opportunities and opened wide horizons for students of medical colleges. Online education has already begun in the Syrian Arab Republic, leading to significant studies in various medical fields. For instance, one study focused on evidence-based medicine as an asynchronous online course and found that it effectively improved the competencies of Syrian health professionals (26).

In the dental field, multiple studies have demonstrated the effectiveness of online education. One study showed its positive impact on dental students' knowledge of dental pain management and the local anesthesia methods (35), while another highlighted its benefits in improving the learning of undergraduate dental students in Special Care Dentistry (36). Additionally, an investigation into medical coding as an online course among medical graduates revealed that it effectively increased their knowledge in this area (37). These studies shed light on the experience of online medical education in Syria, indicating promise for health professionals in the Arab world despite limited resources and challenges. Nevertheless, further work is needed to enhance the design and delivery of online education in the Arab world (38).

Conclusion

The findings of the present study demonstrate that the online pharmaceutical apprenticeship course was successful, despite encountering some challenges. Following the educational intervention, the student's knowledge levels showed significant improvement compared to before, which is expected to positively impact their competencies as future community pharmacists and primary healthcare providers. The improvement is crucial for effectively reduce medication errors, which can be prevented through proper training and knowledge. The higher average scores attained by students indicate that e-learning can be an effective solution for generating new learning opportunities and expanding the perspectives of students in medical colleges, particularly pharmacy students.

Ethical considerations

Ethical approval was obtained from the ethical research committee of the Syrian Virtual University (SVU), Number: 35/0, dated February 17-2021.

Artificial intelligence utilization for article writing

No.

Acknowledgment

The authors would like to thank all participating students and everyone who provided comments and suggestions that led to this study's improvement—also, Dr. Samar Alzeer and Dr.Shaden Haddad for their helpful feedback.

Conflict of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

Author contributions

Alaa Abou Halawah is the principal researcher collected participants group and Data, designed and implemented the online course, analyzed the results .

Both Mayssoon Dashash and Adnan Baddour supervised the study, participated in designation and implementation of the course.

Both A.AH and MD participated in writing and revising the manuscript before submission.

All authors read and approved the final manuscript.

Supporting resources

This study is supported by the Syrian Virtual University, Syria.

Data availability statement

The data that support the findings of this study are available from the corresponding author, [AAHalawah], upon reasonable request.

References

1. Linden-Lahti C, Takala A, Holmström AR, Airaksinen M. Applicability Of Drug-Related Problem (DRP) classification system for classifying severe medication errors. BMC Health Services Research. 2023;23(1):743. [https://doi.org/10.1186/s12913-023-09763-3]

[DOI: 10.61186/edcj.17.54.139]

2. Karet GB. Linguistic analysis of generic-generic drug name pairs prone to wrong-drug errors for which tall-man lettering is recommended. Therapeutic Innovation & Regulatory Science. 2023;57:751–8. [https://doi.org/10.1007/s43441-023-00526-0]
3. Wondmieneh A, Alemu W, Tadele N, Demis A. Medication administration errors and contributing factors among nurses: a cross sectional study in tertiary hospitals, Addis Ababa, Ethiopia. BMC Nursing. 2020;19(4):1–9. [https://doi.org/10.1186/s12912-020-0397-0]
4. Caboral-Stevens M, Ignacio RV, Newberry G. Undergraduate nursing students' pharmacology knowledge and risk of error estimate. Nurse Education Today. 2020;93:104540. [https://doi.org/10.1016/j.nedt.2020.104540]
5. Vemuri N, Sneed K, Pathak Y. Medication errors: an ethical analysis. Biomedical Journal of Scientific and Technical Research. 2022;45(2):36208-212. [https://doi.org/10.26717/BJSTR.2022.45.007162]
6. Warren R, Young L, Carlisle K, Heslop I, Glass B. Public health competencies for pharmacists: a scoping review. Pharmacy Education. 2021;21(1):731–58. [https://doi.org/10.46542/pe.2021.211.731758]
7. Valliant SN, Burbage SC, Pathak S, Urick BY. Pharmacists as accessible health care providers: quantifying the opportunity. Journal of Managed Care & Specialty Pharmacy. 2022;28(1):85–90. [https://doi.org/10.18553/jmcp.2022.28.1.85]
8. Mertens JF, Koster ES, Deneer VH, Bouvy ML, van Gelder T. Factors influencing pharmacists' clinical decision making in pharmacy practice. Research in Social and Administrative Pharmacy. 2023;19(9):1267-77. [https://doi.org/10.1016/j.sapharm.2023.05.009]
9. Esmalipour R, Larijani B, Mehrdad N, Ebadi A, Salari P. The ethical challenges in pharmacy practice in community pharmacies: a qualitative study. Saudi Pharmaceutical Journal. 2021;29(12):1441–8. [https://doi.org/10.1016/j.jsps.2021.11.003]
10. Alsulami Z, Conroy S, Choonara I. Medication errors in the Middle East countries: a systematic review of the literature. European Journal of Clinical Pharmacology. 2012;69(4):995-1008. [https://doi.org/1010.1007/s00228-012-1435-y]
11. Engels F. Pharmacology education: reflections and challenges. European Journal of Pharmacology. 2018;833:392–5. [https://doi.org/10.1016/j.ejphar.2018.06.032]
12. Držaić M, Kummer I, Mucalo I, Bruno A, Ortner Hadžiabdić M. Identifying self-assessed competencies and areas for improvement within community pharmacist-preceptors support during pre-registration training. BMC Medical Education. 2018;18(1):303. [https://doi.org/10.1186/s12909-018-1413-x]
13. Naseralallah LM, Hussain TA, Jaam M, Pawluk SA. Impact of pharmacist interventions on medication errors in hospitalized pediatric patients: a systematic review and meta-analysis. International Journal of Clinical Pharmacy. 2020;42(4):979–94. [https://doi.org/10.1007/s11096-020-01034-z].
14. Bahnassi A. Pharmacy education and practice in Syria: past, present, and future. Journal of the American College of Clinical Pharmacy. 2020;3(6):1079-1084. [https://doi.org/10.1002/jac5.1236]
15. Bartolo NS, Pizzuto MA, Wirth F, Szijj JV, Serracino-Inglott A, Azzopardi LM. The shift from class-based to online learning during COVID-19: a student and academic perception. Pharmacy Education. 2020;20(2):290–6. [https://doi.org/10.46542/pe.2020.202.290296]
16. Salter SM, Karia A, Sanfilippo FM, Clifford RM. Effectiveness of e-learning in pharmacy education. American Journal of Pharmaceutical Education. 2014;78(4):0.
83. [https://doi.org/10.5688/ajpe78483]
17. Alkoudmani RM, Elkalmi RM, Apolinário-Hagen J, Alkhoshaiban AS, Al-Essa RK. Pharmacists' familiarity with e-learning in transferring pharmaceutical knowledge in the Arab world. Archives Of Pharmacy Practice. 2021;12(2):34–9. [https://doi.org/10.51847/pgkzyjjyvf]
18. Fernández-Batanero JM, Montenegro-Rueda M, Fernández-Cerero J, Tadeu P. Online education in higher education: emerging solutions in crisis times. Heliyon. 2022;8(8):e10139. [https://doi.org/10.1016/j.heliyon.2022.e10139]
19. Patel SR, Margolies PJ, Covell NH, Lipscomb C, Dixon LB. Using instructional design, analyze, design, develop, implement, and evaluate, to develop e-learning modules to disseminate supported employment for community behavioral health treatment programs in New York State. Frontiers in Public Health. 2018;6:113. [https://doi.org/10.3389/fpubh.2018.00113]
20. Fay MP, Proschan MA. Wilcoxon-Mann-Whitney or t-test? On assumptions for hypothesis tests and multiple interpretations of decision rules. Statistics Surveys. 2010;4(0):1-39. [https://doi.org/10.1214/09-SS051]
21. Delungahawatta T, Dunne SS, Hyde S, et al. Advances in e-learning in undergraduate clinical

[DOI: 10.61186/edcj.17.54.139]

medicine: a systematic review. BMC Medical Education. 2022;22(1):711. [https://doi.org/10.1186/s12909-022-03773-1]
22. Alqurshi A. Investigating the impact of COVID-19 lockdown on pharmaceutical education in Saudi Arabia– a call for a remote teaching contingency strategy. Saudi Pharmaceutical Journal. 2020;28(9):1075-1083. [https://doi.org/10.1016/j.jsps.2020.07.008]
23. Aristovnik A, Kerzic D, Ravselj D, Tomazevic N, Umek L. Impacts of the COVID-19 pandemic on life of higher education students: a global perspective. Sustainability. 2020;12(20):1–34. [https://doi.org/10.3390/su12208438]
24. Jaam M, Naseralallah LM, Hussain TA, Pawluk SA. Pharmacist-led educational interventions provided to healthcare providers to reduce medication errors: a systematic review and meta-analysis. Plos One. 2021;16(6):e0253588. [https://doi.org/10.1371/journal.pone.0253588]
25. Ibrahim OM, Ibrahim RM, Meslamani AZ, Mazrouei NA. Dispensing errors in community pharmacies in the United Arab Emirates: investigating incidence, types, severity, and causes. Pharmacy Practice. 2020;18(4):2111. [https://doi.org/10.18549/PharmPract.2020.4.2111]
26. Kenjrawi Y, Dashash M. The first asynchronous online evidence-based medicine course for Syrian health workforce: Effectiveness and feasibility pilot study. JMIR Formative Research. 2022;6(10):e36782. [https://doi.org/10.2196/36782]
27. Ruehter V, Lindsey C, Graham M, Garavalia L. Use of online modules to enhance knowledge and skills application during an introductory pharmacy practice experience. American Journal of Pharmaceutical Education. 2012;76(4):69. [https://doi.org/10.5688/ajpe76469]
28. Battaglia JN, Kieser MA, Bruskiewitz RH, Pitterle ME, Thorpe JM. An online virtual-patient program to teach pharmacists and pharmacy students how to provide diabetes-specific medication therapy management. The American Journal of Pharmaceutical Education. 2012;76(7):131–1. [https://doi.org/10.5688/ajpe767131]
29. Crouch MA. An advanced cardiovascular pharmacotherapy course blending online and face-to-face instruction. American Journal of Pharmaceutical Education. 2009;73(3):51. [https://doi.org/10.5688/aj730351]
30. Legris MÈ, Séguin NC, Desforges K, et al. Pharmacist web-based training program on medication use in chronic kidney disease patients: impact on knowledge, skills, and satisfaction. Journal of Continuing Education in the Health Professions. 2011;31(3):140–50. [https://doi.org/10.1002/chp.20119]
31. Bykhovsky M, Meier MF, Mager NA. Impact of an online educational program on pharmacy students' knowledge of folic acid and neural tube defects. Journal of Pharmacy Practice. 2014;27(5):513–517. [https://doi.org/10.1177/0897190014544789]
32. Almaghaslah D, Ghazwani M, Alsayari A, Khaled A. Pharmacy students' perceptions towards online learning in a Saudi pharmacy school. Saudi Pharmaceutical Journal. 2018;26(5):617–21. [https://doi.org/10.1016/j.jsps.2018.03.001]
33. Freeman MK, Schrimsher RH, Kendrach MG. Student perceptions of online lectures and WebCT in an introductory drug information course. American Journal of Pharmaceutical Education. 2006;70(6):126. [https://doi.org/10.5688/aj7006126]
34. Hewson C. Can online course-based assessment methods be fair and equitable? Relationships between students' preferences and performance within online and offline assessments. Journal of Computer Assisted Learning. 2012;28(5):488–98. [https://doi.org/10.1111/j.1365-2729.2011.00473.x]
35. Shamsy E, Dashash M. The Effectiveness of online course about pain management and local anesthesia methods for undergraduate dental students. Azerbaijan Medical Journal. 2022;62(10):6129–37. [Online]. Available from: https://www.azerbaijanmedicaljournal.com/volume/AMJ/62/10/the-effectiveness-of-online-course-about-pain-management-and-local-anesthesia-methods-for-undergraduate-dental-students-63aa664ede39f.pdf [Accessed Nov 23, 2023]
36. Almassri N, Dashash M. Evaluation of the effectiveness of electronic educational course about special care dentistry for undergraduate dental students. AMJ. Azerbaijan Medical Journal . 2023;63(4):8741–8. [Online]. Available from: https://www.azerbaijanmedicaljournal.net/volume/AMJ/63/04/evaluation-of-the-effectiveness-of-electronic-educational-course-about-special-care-dentistry-for-undergraduate-dental-students-6435157bdad4a.pdf [Accessed Nov 23, 2023]
37. Allaham A, Baddour A, Ataya J, et al. The effectiveness of online learning in improving the

[DOI: 10.61186/edcj.17.54.139]

knowledge about medical coding: a pilot study | AMJ. wwwazerbaijanmedicaljournalnet. 2023;63(3):8291–9. [Online]. Available from: https://www.azerbaijanmedicaljournal.net/volume/AMJ/63/03/the-effectiveness-of-online-learning-in-improving-the-knowledge-about-medical-coding-a-pilot-study-6411aedc0e838.pdf. [Accessed Nov 23, 2023]

38. Dashash , M. The implementation of online medical education in the arab world. In: et al. (eds.) Higher Education in the Arab World. Switzerland: Springer Nature; 2023.p.271–294. [https://doi.org/10.1007/978-3-031-33568-6_14]

[DOI: 10.61186/edcj.17.54.139]