ORIGINAL ARTICLE

Effects of Pharmacotherapy Training Course on Improving the Drug Prescription Skills of Medical Students: A Pharmacy-based Intervention

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Background: Due to the growing issue of medical errors, ensuring safer, and evidence-based prescribing practices, a training course on rational drug prescription for medical students is mandatory. Currently, the training course on rational drug prescription in Mashhad University of Medical Sciences and other faculties has not been defined for medical interns. The present study investigated the effects of a pharmacy-based rational pharmacotherapy training course on improving medical students' pharmacotherapy knowledge and skills.

Method: In 2023, thirty internal internship students of Mashhad University of Medical Sciences were assigned to the intervention and control groups. A pre-test survey was administered to all participants at the beginning of their internal internship. The intervention group underwent a seven-day course on rational pharmacotherapy at the hospital pharmacy unit. In contrast, the control group had their regular internship training. Post-tests were conducted for both groups at the end of their internal internship period. Ultimately, the pre-test and post-test scores were compared between the two groups.

Results: A total of 30 interns with an average age of 24.88 ± 0.97 years were included in the study. There was no significant difference in their basic level of prescription knowledge between the two groups (p=0.314). Following intervention, a substantial improvement was noted in the overall post-test score of the intervention group (P=0.001).

Conclusion: A pharmacy-based pharmacotherapy training course can substantially improve medical students' pharmacotherapy knowledge and skills. The present findings advocate for the integration of such courses into the medical education curricula, aiming to enhance rational drug prescription practices among future physicians.

Keywords: Drug Therapy, Drug Prescriptions, Education, Medical

آثار الدورة التدريبية للعلاج الدوائي على تحسين مهارات وصف الأدوية لدى طلاب الطب: التدخل القائم على الصيدلة

الخلفية: نظرًا لتزايد مشكلة الأخطاء الطبية، وضمان ممارسات وصف أكثر أمانًا وقائمة على الأدلة، فإن دورة تدريبية حول الوصف العقلاني للأدوية لطلاب الطب إلزامية. حاليًا، لم يتم تحديد الدورة التدريبية حول الوصف العقلاني للأدوية في جامعة مشهد للعلوم الطبية والكليات الأخرى للمتدربين الطبيين. بحثت الدراسة الحالية في آثار الدورة التدريبية للعلاج الدوائي العقلاني القائم على الصيدلة على تحسين معرفة ومهارات العلاج الدوائي لدى طلاب الطب.

الطريقة: في عام ٢٠٢٣، تم تعيين ثلاثين طالبًا من طلاب التدريب الداخلي بجامعة مشهد للعلوم الطبية في مجموعات التدخل والسيطرة. تم إجراء مسح ما قبل الاختبار لجميع المشاركين في بداية تدريبهم الداخلي. خضعت مجموعة التدخل لدورة مدتها سبعة أيام حول العلاج الدوائي العقلاني في وحدة صيدلية المستشفى. في المقابل، حصلت المجموعة الضابطة على تدريب داخلي منتظم. وأجريت الاختبارات البعدية لكلتا المجموعتين في نهاية فترة التدريب الداخلي. وفي النهاية، تمت مقارنة درجات الاختبار القبلي والاختبار البعدي بين المجموعتين.

النتائج: تم تضمين ما مجموعه ٣٠ متدربًا بمتوسط عمر ٢٤,٨٨ ± ٠,٩٧ سنة في الدراسة. لم يكن هناك اختلاف كبير في المستوى الأساسي للمعرفة الطبية بين المجموعتين (ع = ٠,٣١٤). بعد التدخل، لوحظ تحسن كبير في النتيجة الإجمالية للاختبار اللاحق لمجموعة التدخل (P = 0.001).

الاستنتاج: يمكن للدورة التدريبية للعلاج الدوائي القائم على الصيدلة أن تحسن بشكل كبير معرفة ومهارات العلاج الدوائي لدى طلاب الطب. وتدعو النتائج الحالية إلى دمج مثل هذه الدورات في مناهج التعليم الطبي، بهدف تعزيز ممارسات وصف الأدوية العقلانية بين أطباء المستقبل.

الكلمات المفتاحية: العلاج الدوائي، الوصفات الدوائية، التعليم، الطبية

تأثیر دوره آموزشی دارودرمانی بر مهارت‌های دارودرمانی دانشجویان پزشکی: یک مداخله مبتنی بر داروسازی

زمینه و هدف: با توجه به رشد روزافزون خطاهای پزشکی، اطمینان از شیوه های تجویز ایمن و مبتنی بر شواهد، برگزاری دوره آموزشی تجویز منطقی دارو و نسخه نویسی برای دانشجویان پزشکی الزامی است. در حال حاضر دوره آموزشی تجویز دارو مناسب در دانشگاه علوم پزشکی مشهد و سایر دانشکده ها برای کارورزان پزشکی تعریف نشده است. مطالعه حاضر به بررسی تأثیر دوره آموزشی دارودرمانی منطقی مبتنی بر داروسازی بر ارتقای دانش و مهارت‌های دارودرمانی دانشجویان پزشکی می‌پردازد.

روش: در سال ۱۴۰۲ سی دانشجوی کارورزی داخلی دانشگاه علوم پزشکی مشهد در دو گروه مداخله و کنترل قرار گرفتند. یک آزمون ابتدایی از همه شرکت کنندگان در شروع کارآموزی داخلی انجام گرفت. گروه مداخله یک دوره هفت روزه دارودرمانی را در واحد داروسازی بیمارستان گذراندند. در مقابل، گروه کنترل به طور منظم آموزش کارآموزی خود را سپری کردند. در نهایت یک آزمون از هر دو گروه در پایان دوره کارآموزی داخلی گرفته شد و نمرات آزمون ابتدایی و نهایی بین دو گروه مقایسه شد.

یافته ها: سی کارورز با میانگین سنی ۰/۹۷ ± ۲۴/۸۸ سال مطالعه وارد شدند. تفاوت معنی داری در سطح دانش پایه نسخه نویسی آنها بین دو گروه وجود نداشت (P=0.314). پس از مداخله، بهبود قابل توجهی در نمره کلی آزمون نهایی در گروه مداخله مشاهده شد (P=0.001).

نتیجه گیری: دوره آموزشی دارودرمانی مبتنی بر داروسازی می‌تواند دانش و مهارت‌های دارودرمانی دانشجویان پزشکی را به میزان قابل توجهی بهبود بخشد. یافته‌های ما از ادغام چنین دوره‌هایی در برنامه‌های درسی آموزش پزشکی، با هدف تقویت شیوه‌های منطقی تجویز دارو در میان پزشکان آینده حمایت می‌کند.

واژه های کلیدی: دارودرمانی، تجویز دارو، آموزش، پزشکی

طبی طالب علموں کی منشیات کے نسخے کی مہارت کو بہتر بنانے پر فارماکو تھراپی کے تربیتی کورس کے اثرات: فارمیسی پر مبنی مداخلت

پس منظر: طبی غلطیوں کے بڑھتے ہوئے مسئلے کی وجہ سے، محفوظ اور شواہد پر مبنی نسخے کے طریقوں کو یقینی بنانے کے لیے، طبی طلباء کے لیے دواؤں کے عقلی نسخے پر ایک تربیتی کورس لازمی ہے۔ فی الحال، مشہد یونیورسٹی آف میڈیکل سائنسز اور دیگر فیکلٹیز میں دواؤں کے عقلی نسخے سے متعلق تربیتی کورس میڈیکل انٹرن کے لیے متعین نہیں کیا گیا ہے۔ موجودہ مطالعہ نے طبی طلباء کے فارماکوتھراپی کے علم اور مہارتوں کو بہتر بنانے پر فارمیسی پر مبنی عقلی فارماکوتھراپی تربیتی کورس کے اثرات کی چھان بین کی۔

طریقہ: ۲۰۲۳ میں، مشہد یونیورسٹی آف میڈیکل سائنسز کے تیس داخلی انٹرنشپ طلباء کو مداخلت اور کنٹرول گروپوں کے لیے تفویض کیا گیا۔ تمام شرکاء کو ان کی داخلی انٹرنشپ کے آغاز میں ایک پری ٹیسٹ سروے کا انتظام کیا گیا تھا۔ مداخلت کرنے والے گروپ نے ہسپتال کے فارمیسی یونٹ میں عقلی فارماکوتھراپی پر سات روزہ کورس کروایا۔ اس کے برعکس، کنٹرول گروپ نے باقاعدہ انٹرن شپ کی تربیت حاصل کی۔ دونوں گروپوں کے لیے ان کی داخلی انٹرنشپ مدت کے اختتام پر پوسٹ ٹیسٹ کیے گئے۔ بالآخر، دونوں گروپوں کے درمیان پری ٹیسٹ اور پوسٹ ٹیسٹ سکور کا موازنہ کیا گیا۔

نتائج: ۲۳٫۸۸ ± ۰٫۹۷ سال کی اوسط عمر کے ساتھ کل ۳۰ انٹرنز کو مطالعہ میں شامل کیا گیا تھا۔ دو گروپوں (p = 0.314) کے درمیان ان کے نسخے کے علم کی بنیادی سطح میں کوئی خاص فرق نہیں تھا۔ مداخلت کے بعد، مداخلت گروپ (P = 0.001) کے مجموعی پوسٹ ٹیسٹ سکور میں کافی بہتری نوٹ کی گئی۔

نتیجہ: فارمیسی پر مبنی فارماکوتھراپی کا تربیتی کورس طبی طلباء کے فارماکوتھراپی کے علم اور مہارت کو کافی حد تک بہتر بنا سکتا ہے۔ موجودہ نتائج طبی تعلیم کے نصاب میں ایسے کورسز کے انضمام کی وکالت کرتے ہیں، جس کا مقصد مستقبل کے معالجین کے درمیان دواؤں کے نسخے کے عقلی طریقوں کو بڑھانا ہے۔

مطلوبہ الفاظ: منشیات کا علاج، ادویات کے نسخے، تعلیم، طبی

INTRODUCTION

Pharmacotherapy stands as a prevalent therapeutic method utilized by physicians across primary and secondary care settings (1, 2). Nevertheless, healthcare practitioners frequently encounter difficulties in staying abreast of the swiftly advancing pharmacotherapy landscape, potentially resulting in subpar prescribing practices and adverse health effects (3). Given that over half of all physician consultations culminate in a prescription, it is imperative for medical practitioners to adeptly, safely, and judiciously prescribe drugs in alignment with rational pharmacotherapy principles (4).

Rational pharmacotherapy refers to a systemic approach to carefully selecting and prescribing medications based on scientific evidence and patient characteristics. This approach aims to ensure that patients receive adequate medications at reasonable costs, for an adequate period of time, and in doses appropriate for their clinical condition (5, 6). Irrational prescribing has detrimental social, economic, and legal effects. These include patient dissatisfaction, deterioration of the patient-physician bond, disease exacerbation, and prolonged hospital stays, and increased treatment expenses for individuals and governments (7). Even though rational prescribing is widely accepted to be important, over 50% of all pharmaceuticals are prescribed, delivered, or marketed incorrectly (8). It is estimated that 56.3% of elderly patients in palliative care received at least one inappropriate medication. Moreover, the last meta-analysis reported the prevalence of inappropriate medication usage in older patients is 36.7% (9, 10). Therefore, adherence to a high prescribing standard is essential to ensure the most beneficial therapeutic outcomes and minimize undesired effects. One of the most common obstacles to reducing inappropriate prescribing is physicians' lack of prescribing skills that needs to be overcome. (11, 12).

Despite all the advances in pharmacotherapy, the teaching of this topic to undergraduate medical students remains inadequate. Consequently, many graduates lack competencies and feel underprepared for the prescribing challenges (1). Pharmacotherapy is usually taught as lectures in medical schools, and many students find it difficult to apply their theoretical knowledge in practice (13). The majority of prescription-related errors are committed by junior doctors, so undergraduate education should provide practical training to improve their prescription qualities. Numerous interventions have been developed to address this demand, with education for healthcare professionals standing out as one of the most widely employed approaches (1, 14). The results suggest that proper prescription training can increase the accuracy and rationality of prescribing practices (5, 15-18). However, further research is needed to determine the best practices and strategies that can be used to improve the quality of education for medical students.

Currently, there is no structured training course on rational pharmacotherapy for medical interns at Mashhad University of Medical Sciences or faculties of medicine. Conversely, the proliferation of residency and fellowship programs in teaching hospitals has diminished the opportunities for medical interns to engage in the prescription process, consequently diminishing their exposure and proficiency in this domain. Hence, there is a need for research aimed at developing practical training courses and laying the groundwork for integrating them into our medical education curriculum. The present study introduced a pharmacy-based rational pharmacotherapy course and aimed to investigate its effects on the pharmacotherapy skills of medical interns at Mashhad University of Medical Sciences, Iran.

METHODS

Study design and participants

A controlled pre/post study of an educational intervention was conducted at Mashhad University of Medical Sciences, Iran, from March to September 2023. The participants in this study were senior medical students undergoing their three-month internal medicine internship at Ghaem Hospital, Mashhad, Iran. The inclusion criteria were consent to participate in the study, and the exclusion criteria were unwillingness to cooperate during any time of the research and being absent from more than 50% of the interventional sessions.

Intervention

Fifteen medical students were placed in the intervention group using random sampling. The intervention group (in groups of five) attended a one-week course on rational pharmacotherapy at the hospital pharmacy and received training in selecting the most appropriate pharmacotherapy among alternatives. Training was provided by expert physicians with extensive experience in teaching clinical pharmacology. The sessions consisted of seven 4-hours pharmacy-based interactive meetings during which the trainers delivered lectures on treating several common conditions, focusing on the following topics: diarrhea, Diabetes Mellitus (DM), dyslipidemia, vitamin D deficiency, brucellosis, Myocardial Infarction (MI), allergic rhinitis, Osteoarthritis (OA), common cold, Steven's-Johnson Syndrome (SJS), Urinary Tract Infection (UTI), Otitis Media (OM). During the sessions, medical interns discussed the real cases they encountered in the pharmacy with their trainer. Through these steps, participants had the opportunity to identify the pharmacological options available for treating the patients. They were also able to determine the number and type of prescribed medications, their pharmaceutical form, the frequency of medication intake, duration of the treatment, possible side effects, etc. Furthermore, they were trained to write complete, correct, unambiguous prescriptions that were also cost-effective. During the course, the researchers used the Iranian Pharmacopeia as a reference. The outlined objectives of this educational intervention consisted of the following:

- To understand the core principles of writing an accurate prescription
- To improve medical interns' knowledge and attitudes about treating common diseases, including pharmacological options, treatment duration, etc.
- Increasing their knowledge about different dosages and forms available in the market, dosage calculation, different routes of administration, and cost-efficiency

● To increase awareness about commonly seen adverse drug reactions, drug interactions, and drug allergy
● Learning to use evidence-based prescribing skills to improve patient care

The control group participants, matched based on their pre-internship exam scores with the intervention group, received the internship training as usual.

Outcome measures

A structured 12-part questionnaire modified from a survey conducted by Moghimi Shahri et al. (19) was used in this study. The present researchers administered a pre-intervention survey to determine all participants' baseline knowledge in the following topics: diarrhea, DM, dyslipidemia, vitamin D deficiency, brucellosis, MI, allergic rhinitis, OA, common cold, SJS, UTI, and OM. In detail, the questions assessed the students' knowledge of the following subjects: prescription writing skills, commonly used pharmaceutical agents, treatment duration, dosage forms and route of administration, and adverse drug reactions. Each question carries ten marks. Demographic information was also collected at baseline.

In order to prevent any impact from the interaction between the intervention and control groups, participants in the control group were examined prior to those in another group. At the end of their internal medicine internship, the students were asked again to complete the same questionnaire, and two trained reviewers performed the analysis. Each reviewer evaluated all the questionnaires independently. The researchers compared the results and resolved any discrepancies through consensus.

After the intervention, the intervention group participants were given a 10-part satisfaction questionnaire assessing the acceptability of the course and its impact on the students' knowledge. This questionnaire contained eight items, composed of a 5-point Likert-type scale (1 = 'strongly disagree,' 5 = 'strongly agree'), and one item asking whether the participants would recommend this course to other students.

Throughout the study, the status of the interns participating in the study, whether they were in the intervention group or completed their internship as usual, remained unknown to the questionnaire evaluators and the article authors. This blinding was implemented to reduce the potential for bias.

Statistical analysis

Descriptive statistics were calculated for all demographic characteristics and assessment responses, including mean (standard deviation) or median (interquartile range) for continuous variables and frequency and percent for categorical variables. Pre- and post-intervention assessments were compared using the Paired Samples T-test and Wilcoxon signed ranks test. Baseline participant characteristics and assessment responses were compared between groups using an independent T-test and Mann-Whitney test. Chi-square or Fischer`s exact tests were also used for categorical variables. For all analyses, the threshold for significance was set at the level of < 0.05. Furthermore, the Bonferroni method corrected the significance level to reduce the Type I error associated with multiple comparisons. Based on the number of tests conducted, the adjusted significance level was calculated and the statistical results were then reported based on this corrected significance level. All statistical analyses were conducted with the SPSS version 22.

RESULTS

A total of 30 students with an average age of 24.88 ± 0.97 participated in the current study. The two groups were homogenous in terms of their demographic and personal characteristics except for the length of time since the start of their internship (table 1).

Table 2 shows the exact results of the pre-test and post-test in different areas. As shown, the mean of the pretest score was not significantly different between the two groups, while in post-test results, there were remarkable differences

Table 1. Participants' baseline characteristics

Characteristics		All Participants	Intervention group	Control group	P value
Gender	Male	16 (53)	7 (46.7)	9 (60)	0.464*
	Female	14 (47)	8 (53.3)	6 (40)	
Age (years)		24.88 ± 0.97	24.57±0.75	25.23±1.09	0.078**
Marital Status	Single	23 (79.3)	12 (80)	11 (78.8)	0.999***
	Married	6 (20.7)	3 (20)	3 (21.4)	
Residency status	Private home resident	23 (76.6)	11 (73.3)	12 (80)	0.999<***
	residence halls	7 (23.3)	4 (26.7)	3 (20)	
Medical school costs	Tuition-free	26 (86.7)	12 (80)	14 (83.3)	0.598***
	Tuition	4 (13.3)	3 (20)	1 (6.7)	
Grade Point Average		16.41±0.85	16.70±0.92	16.11±0.70	0.070****
Medical internship duration (months)		5.45±3.91	4.13±3.48	7.66±3.74	0.029****

Data are reported as mean ± SD, median (interquartile range), or frequency (percent).
*Chi-Square; **Mann-Whitney test; ***Fischer`s Exact test; ****Independent Sample T test

Table 2. The results of pre and post-tests in both intervention and control groups

The items of the assessment	Pre-test results			Post-test results		
	Control group (Mean+SD)	Intervention group (Mean+SD)	P value [a]	Control group (Mean+SD)	Intervention group (Mean+SD)	P value [a]
Diarrhea	2.82±2.74	3.08±2.79	0.643**	3.03±3.10	6.56±3.35	0.009**
Common Cold	5.50±2.92	4.83±3.43	0.572*	4.80±3.17	5.83±3.80	0.426*
Diabetes Mellitus	2.56±2.94	1.53±2.03	0.243**	2.26±2.98	5.53±3.83	0.027**
Dyslipidemia	2.13±4.10	3.33±4.87	0.604**	0±0	6±5.07	0.001>**
Vitamin D Deficiency	2.66±2.20	3.33±1.67	0.359*	3.30±2.13	5.91±2.76	0.007*
Steven Johnson's Syndrome	0.2±0.77	2.46±4.29	0.117**	1.73±3.22	4±5.07	0.180**
Brucellosis	2.70±2.56	3.66±3.91	0.492**	1.76±2.36	5.60±4.38	0.034**
Urinary Tract Infection	1.53±2.25	1.73±2.40	0.945**	2.36±3.25	4.63±4.24	0.173**
Myocardial Infarction	2.81±2.36	3.93±2.91	0.259*	2.71±2.21	6.56±4.10	0.017**
Allergic Rhinitis	2.93±2.89	2.73±3.53	0.384**	2.66±3.65	6.76±3.13	0.002**
Otitis media	2.66±3.03	3.20±3.52	0.862**	3.06±3.34	4.33±4.02	0.351*
Osteoarthritis	4.40±3.22	5.33±3.51	0.433**	4±2.07	7.13±2.38	0.002*
total score	32.55±16.25	38.81±17.17	0.314*	31.95±10.98	68.88±29.20	0.001**

*Independent Sample T test; ** Mann-Whitney test
a: Comparison between intervention and control group; b: Comparison between pre and post-test results in the control group; c: Comparison between pre and post-test results in the intervention group

between the two groups in diarrhea, dyslipidemia, allergic rhinitis, and OA after correcting the significant level. However, no significant difference was observed in the post-test mean scores of DM, common cold, vitamin D deficiency, Brucellosis, SJS, MI, UTI, and OM between the two groups. Moreover, the results demonstrated that although the total mean scores in the control group did not significantly change between the pre-test and post-test surveys (P-value＝0.314), the intervention could significantly increase the mean total scores (P-value＝0.001).

The present researchers also investigated the comparison of the change in the post-test score compared to the pre-test in two groups. DM, MI, and total score had significant changes between the two groups after correcting significant level (table 3).

The students' overall satisfaction and the impact of the intervention on their skills are indicated with a score between 1-5. As can be seen, all the attendants recommended participation in this course to their peer students. Moreover, all participants were satisfied with the course, with 55% of them giving it a perfect score. For more information, please refer to Table 4.

Table 3. Post-test score changes compared to pretest scores between intervention and control group participants

The items of the assessment	Intervention group	Control group	P value
Diarrhea	5.30±3.48	0.28±4.29	0.063**
Common Cold	1.00±5.43	-0.70±3.63	0.323*
Diabetes Mellitus	0.40±4.07	-0.30±2.60	0.002**
Dyslipidemia	2.66±4.57	-2.13±4.10	0.005**
Vitamin D Deficiency	2.58±2.16	0.63±1.84	0.013*
Steven Johnson's Syndrome	1.53±3.52	1.53±3.09	0.801**
Brucellosis	1.93±3.99	-0.73±2.52	0.037*
Urinary Tract Infection	2.90±4.29	0.83±3.64	0.079**
Myocardial Infarction	2.63±2.65	-0.10±1.45	0.002*
Allergic Rhinitis	4.03±3.43	-0.26±4.26	0.005*
Otitis Media	1.13±1.99	0.40±3.06	0.572**
Osteoarthritis	1.80±4.73	-0.40±3.81	0.309**
Total score	30.06±21.59	-0.60±14.11	0.001>*

*Independent Sample T-test; ** Mann-Whitney test
Data are reported by mean (SD) and median (interquartile range)

DISCUSSION

It was widely recognized that improving prescribing practices was crucial for achieving the best possible patient outcomes (20). Over the years, implementing practical changes in the medical education program has been a major challenge for professors and planners in this field. Many countries have introduced educational programs aimed at equipping medical interns with the necessary knowledge of pharmacotherapy (1).

This study assessed the impact of a structured educational program, based in a clinical pharmacy setting, on medical interns' competency in rational prescribing and their understanding of pharmacotherapy. The survey encompassed 30 medical interns undertaking their internal medicine internship. Of these, a subgroup of fifteen interns participated in an intensive course on rational prescribing

Table 4. Participants' satisfaction and acceptability of the pharmacy-based educational intervention

Question Item	Scale	Frequency	Percentage
Increasing the knowledge and skills of prescription writing	1	1	6.7
	2	5	33.3
	3	2	13.3
	4	6	40
	5	1	6.7
Knowing the side effects and interactions of commonly used drugs	1	1	6.7
	2	7	46.7
	3	2	13.3
	4	4	26.7
	5	1	6.7
The ability to adjust the dosage of commonly used drugs according to the specific conditions	1	4	26.7
	2	4	26.7
	3	4	26.7
	4	2	13.3
	5	1	6.7
Applying the newest findings to treat patients	1	2	13.3
	2	4	26.7
	3	2	13.3
	4	4	26.7
	5	3	20
Getting to know your limitations and weaknesses in the discussion of treatment and prescription	1	1	6.7
	2	2	13.3
	3	3	20
	4	3	20
	5	6	40
The final evaluation of this course was a good reflection of what was learned.	1	2	13.3
	2	5	33.3
	3	4	26.7
	4	4	26.7
	5	0	0
The final evaluation methods of this course were limited.	1	1	6.7
	2	3	20
	3	7	46.7
	4	3	20
	5	1	6.7
In general, I am satisfied with participating in this course.	1	0	0
	2	0	0
	3	5	33.3
	4	2	13.3
	5	8	53.3
I also recommend this course to other students.	1	15	100
	2	0	0

practices within the hospital's pharmacy department.

The baseline prescription analysis revealed that the participants' rational prescribing and pharmacotherapy skills were inadequate, and they improved only after participating in pharmacy-based training course. This finding was consistent with the results of the study conducted by Oshikoya et al. (21) which evaluated the medical students' knowledge of clinical pharmacology, drug interactions, and side effects. The results indicated that a significant number of participants were weak in rational prescribing, and therefore, the authors found it necessary to provide training courses on rational pharmacotherapy knowledge.

The results of the present study indicated no difference in the pre-test scores between the two groups; however, at the end of the intervention, the post-test's total score in the intervention group were significantly higher than the control group. Similarly, Nishanthi et al. (22) found that a short-structured learner-centric training program, based on the WHO guide to good prescribing, significantly improved medical interns' knowledge of rational drug use and their rational drug prescribing skills. This was evidenced by a substantial increase in post-test scores and the quality of prescriptions written by the interns. A quasi-experimental study by Bebitoglu et al. (23) revealed that the long-term retention of rational pharmacotherapy skills was better when the course was conducted in later years of education. This was likely because students in later years were more involved in the patient therapy process during their clinical education, leading to better maintenance of their prescribing skills over time. Moghimi et al. (19) also reported significant enhancements in the number of pharmaceutical agents prescribed by medical interns after the rational pharmacotherapy training courses. However, this significant difference was not reported in the proper prescription of antimicrobial drugs, corticosteroids, and injectable drugs. These results were also consistent with the present findings and showed that by implementing training courses on rational pharmacotherapy, medical students' prescribing competency could be significantly improved. Moreover, the systematic review by Mokrzecki et al. (1) highlighted the lack of formal education interventions for medical students in writing discharge or outpatient prescriptions. While educational interventions generally improved prescribing abilities, there was no standardized, validated teaching and assessment method. The review concluded that although educational interventions enhanced prescribing skills, inconsistencies in teaching methods, assessment, and timing remained. Addressing these gaps was crucial to prevent unnecessary burdens on the health system and potential harm to patients.

The results of the post-intervention questionnaire revealed that all the students in the Intervention group would recommend participating in this course to other students. However, some students were not fully satisfied with certain aspects, such as the increase in their knowledge of drug interactions. This could be due to the short duration of the course, which is expected to be addressed through future planning.

LIMITATIONS

There are several limitations to this study. A longer follow-up would have been beneficial to determine whether the improvements persisted. Since the present sample was small and limited to one teaching hospital, it's possible that the findings cannot be applied to other contexts. To the best of our knowledge, no prior research has been conducted in our country on the impact of the pharmacy-based rational pharmacotherapy training course, so we can highlight the novel approach taken by this study.

CONCLUSION

This study demonstrated the effectiveness of a structured pharmacy-based training course in enhancing medical interns' rational prescribing skills and pharmacotherapy knowledge. By incorporating such interventions into the medical education program, the stakeholders can achieve a safer and more rational approach to medication management, as well as, prevent and reduce medical errors.

Ethical considerations

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors. This study was approved by the ethics committee of Mashhad University of Medical Sciences (IR.MUMS.REC.1401.078).

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