Original Article

Access this article online
Quick Response Code:

Website: www.jehp.net
DOI: 10.4103/jehp.jehp_1152_20

The short- and long-term effects of a course on rational drug use: A comparative study between prefinal- and final-year undergraduate medical students who attended the course in different clinical years

Berna Terzioglu Bebitoglu, Elif Oguz, Nazife Gökçe Acet, Esra Akdeniz[1], Özlem Sarikaya[1]

Abstract:

BACKGROUND: Rational pharmacology use and appropriate prescribing are among the key learning outcomes in medical education. Some medical faculties include rational pharmacotherapy course in their education programs at different years of education in Turkey. The aims of this study were to investigate the differences in effect of rational pharmacotherapy course on short- and long-terms by comparing two cohorts who attended the course in different clinical years of medical education by identifying which parameters of prescription items are different among groups.

MATERIALS AND METHODS: This quasi-experimental study was conducted in School of Medicine. Participants consisted of 157 students who attended the course in Grade 4 (n = 110, Group A) and Grade 5 (n = 47, Group B). Students were asked to complete a prescribing task both upon completion of the course and 1 year after. The performance in prescribing was determined by prescription scoring form. Repeated measures ANOVA was employed to test the intervention effect between two periods. McNemar test was employed to measure the change in each item on the prescription. Point-biserial correlations between each item on the prescription and their scores on the test as a whole were calculated.

RESULTS: The mean score of Group A dropped to 59.41 (standard deviation [SD] = 14.06) from 90.43 (SD = 8.90), and the mean score of Group B dropped to 73.37 (SD = 12.56) from 83.91 (SD = 10.03). All the prescription components in the scripts of the Group A students worsened significantly, except the "name of drug," whereas Group B students maintained most of them after 1 year.

CONCLUSIONS: This study shows that the long-term retention effect of rational pharmacotherapy course conducted in later years of education is better than the course conducted in earlier years of education, which may be related to the fact that students in later years are more likely to take on responsibility for patient therapy process in clinical education.

Keywords:

Clinical competence, drug prescriptions, medical education, pharmacology, quasi-experimental, undergraduate

Department of Medical Pharmacology, School of Medicine, İstanbul Medeniyet University, İstanbul, Turkey, [1]Department of Medical Education, School of Medicine, Marmara University, İstanbul, Turkey

Address for correspondence:
Dr. Berna Terzioglu Bebitoglu, Department of Medical Pharmacology, School of Medicine, Istanbul Medeniyet University, Unalan Street, North Campus, D Block, 34700 Üsküdar, Istanbul, Turkey.
E-mail: bernaterzioglu@gmail.com

Received: 02-09-2020
Accepted: 06-10-2020
Published: 30-06-2021

How to cite this article: Bebitoglu BT, Oguz E, Acet NG, Akdeniz E, Sarikaya Ö. The short - and long-term effects of a course on rational drug use: A comparative study between prefinal- and final-year undergraduate medical students who attended the course in different clinical years. J Edu Health Promot 2021;10:213.

Introduction

Clinical pharmacology, therapeutic application, and prescribing are among the key learning outcomes in education of medical students.[1] However, students have concerns in choosing the right drug among the drug classes, determination of the total required application dose, calculation of the total required dosage, and duration of treatment, which are important for appropriate prescribing.[2,3]

Poor prescribing leads to unwanted consequences for the patients such as incidence of adverse drug reactions, drug–drug interactions resulting in patients' harm, and increase in health-care costs.[4] In Harding *et al.*'s study evaluating the use of clinical pharmacology knowledge and prescribing skills of junior doctors, they failed to use clinical pharmacology knowledge and found to write scripts that may impair patient safety.[5] Therefore, getting scientific drug information, following treatment guidelines, and life-long evidence-based learning are essential for graduates.

The validated pharmacology training model of the World Health Organization (WHO) is used in many undergraduate medical training, and its effectiveness has been demonstrated to be a useful approach.[6-10] The personal drug (p-drug) selection and writing prescriptions take place in the program of rational pharmacotherapy course. The short- and mid-term effects of this course were studied, whereas the data for long-term effects related to students' competencies in clinical years are limited in medical education literature.[7,9]

This rational pharmacotherapy course conducted as an interactive training course in pharmacotherapy is implemented in our medical curriculum of 4th-year students. Our school was founded in 2012, and when we started this course at the academic year of 2017–2018, we provided the same rational pharmacotherapy course for both fourth- and fifth-grade students. We aimed to investigate the differences between two cohorts who attended the course at the fourth grade and who attended at the fifth grade by comparing their prescriptions 1 year after the course. Prescribing the correct drug, dose, and route and frequency of administration together with considering the individual variability and response, comorbidities, and interactions are essential issues. Therefore, we assessed the educational effect by analyzing the scripts written by students. As the availability of this course is appeared to vary by medical schools and studied in different grades without integration to other clerkships depending on the context of the curriculum and facilities, we aimed to determine the timing for this course that will increase its educational effect and encourage health professionals to write a complete legible prescription. Therefore, the objectives of the study were to evaluate the short- and long-term educational effects of rational pharmacotherapy course on medical students who attended the course in different grades by comparing their scores of prescribing task and by evaluating the correct items of the prescriptions among two groups by identifying the areas of strengths and weaknesses in prescription. The self-competency of prescribing and students' perceptions about the effects of this program are also evaluated.

Materials and Methods

The course definition

"The rational pharmacotherapy course" at our university, School of Medicine, has a 1-week duration, followed by the WHO 6 steps of rational prescribing teaching methodology and learning outcomes.[8,11]

The program on rational pharmacotherapy, which included tutorials, conducted as a total of four sessions each lasting for 120 min. Small group students selected their p-drugs for the uncomplicated case under the supervision of course trainer during these sessions according to the guide.[11] The suitability of the selected drug was verified for a particular patient defined with different levels having complicated problems and prescribing practice as standard procedures according to the WHO guide, "Guide to Good Prescribing."[8] The clinical problem was chosen as essential hypertension from the most commonly seen noncommunicable diseases in Turkey.[12]

The study design

The study was conducted with a total of 157 students who participated in the rational pharmacotherapy course, students who attended the course in Grade 4 (n = 110, Group A), and students who attended the course in Grade 5 (n = 47, Group B). At the academic year, the study was conducted, and we used the WHO 6 steps of rational pharmacotherapy course for both fourth- and fifth-grade students. The study flowchart is presented in Figure 1.

The quasi-experimental design included two comparative cohorts (Groups A and B) and two phases (short- and long-terms) and a quantitative assessment; the first phase data were collected upon completion of the courses to evaluate the short-term educational effect. The second phase data were collected 1 year later to evaluate long-term educational effect. In the second phase, Group A was at the fifth grade of school and Group B was intern doctors.

In both phases, students (both Groups A and B) completed a prescription task for a definite case consisting of a

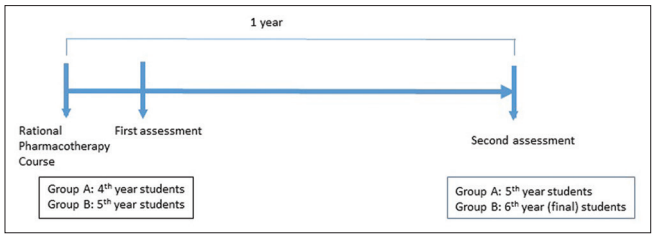

Figure 1: The study flowchart

different vignette. A standard prescription scoring form comprising five categories was used to evaluate students' prescribing and treatment planning. The prescriptions of the students according to the case were assessed using a standard prescription scoring form comprising five categories, and all scripts were scored by the same pharmacologist based on the key criteria, as presented in Table 1. The Prescription Scoring Form adapted from the WHO guide, "Guide to Good Prescribing," and it was concluded by the pharmacologists that the item of the form used as an instrument to measure the theoretical concept has construct validity.[8,10,11,13]

At the end of both phases, the students' reactions were evaluated quantitatively with feedback forms about their opinions of the pharmacotherapy training program to identify their self-competencies of prescribing.

The Research Ethics Committee of School of Medicine approved this study (Date. February 2, 2019/No. 2019/0031). Informed consent was obtained from all participants. All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional and/or National Research Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Statistical analysis

The total score of the prescriptions (dependent variable) for each student was measured both in short- and long-terms after prescribing education (intervention). It was of interest to determine whether term (short- and long-terms) and/or grades (4th year [Group A]/5th year [Group B]) had a significant effect on total scores. We also calculated Pearson's correlation coefficients between the terms for each grade. We employed repeated measures ANOVA model to take into account the dependency of total scores between the terms for each grade where grades were taken as a between-group effect and term as a within-group effect. The significant effects were tested with a paired *t*-test using Bonferroni correction.

The predefined scores for each item were summed to obtain the total score for each student in each term. The total scores of the students were normally distributed, so they were presented with mean, standard deviation (SD), minimum, and maximum values. The Shapiro–Wilk's test, QQ and PP plots, skewness, and kurtosis measures were used to assess the data distribution.

Table 1: Prescription scoring form used to analyze the scripts

Items categories	Prescription items
Format-related items	Patients' name, age, gender, address and diagnosis (4 points each)
	Physician's name, diploma number, signature, address (5 points each)
	Presence of date, "Rp" (Recipe; Latin for "take") (5 points each)
	Readable handwriting (10 points) and use of indelible ink (if not -10 points)
Content-related items	Generic or trade name of drug (10 points), recommended dose (5 points), strength and dosage form (5 points), total amount to be delivered (5 points), instructions and warnings (10 points)

The categorical variables (the correctness of the prescription items) for each grade (Groups A and B) and each term (short- and long-terms) were denoted with frequencies and percentages. It was of interest to test how the correctness of each item in the prescription changed in the long-term for each grade; thus, we employed that McNemar test was employed for all other items with two categories (patient's name, age, gender, address, diagnosis, physician's name, diploma no, signature, address, date, Rp, amount of drugs, name of drug, dose, strength and dosage form, total amount to be delivered, instructions and warnings, and use of indelible ink) in the prescription for both grades [Table 2].

We calculated point-biserial correlations between each item on the prescription and short- and long-term scores, which correlates student scores on one particular item with their scores on the test as a whole. A high point-biserial correlation denotes that a specific item on the prescription has a discriminating role.

All students in Group A and Group B were included in the study; thus, we calculated the achieved power after the study was conducted. The power analysis was conducted using G*Power 3. 1.[14]

All *P* values are two-sided, and $P \leq 0.05$ was considered statistically significant. The statistical analyses were performed with SPSS (IBM SPSS Statistics for Windows, Version 23.0, Armonk, NY, USA) and R program version 3.5.3 (R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria).

Results

The study groups were similar in terms of gender and experience. The age of participants was 24.30 ± 0.62 years for Group A and 24.08 ± 0.86 years for Group B.

Upon completion of each course, all students in both the groups participated (short-term). However, 1 year later, the number of students dropped from 110 to 98 for Group A (response rate in the long-term = 89.1%) and from 47 to 43 for Group B (response rate in the long-term = 91.5%). The results of the repeated measures ANOVA model revealed that the smallest effect size was for grade factor (η^2_p= 0.040) and is converted to f effect size (0.20) to calculate the achieved power. The correlation between short- and long-term scores (correlation among repeated measures) of the Group A students was 0.082, while it was 0.368 for Group B. The achieved power of the study for an f effect size of 0.20 and correlation of 0.082 among the repeated measurements with a total sample size of 156 (assuming an alpha at 0.05) is found as 0.96.

Impact of the course on prescription scores

The mean score of Group A dropped to 59.41 (SD = 14.06) from 90.43 (SD = 8.90), whereas the mean score of Group B dropped to 73.37 (SD = 12.56) from 83.91 (SD = 10.03).

The significant interaction between term and grade was followed with *post hoc* tests to see whether the change in scores was significant in both terms. The results of the paired *t*-test showed that Group A and Group B have significantly lower scores 1 year after the course (t[95] = 19.91; $P \leq 0.001$, t[41] = 5.19; $P < 0.001$, respectively) [Table 3]. The mean scores of each group and their change in time are plotted in Figure 2. The mean plot shows a significant interaction between term and grade and also a decrease of total scores in the long-term for each grade. The mean plot in Figure 2 shows that students in both grades have lower scores in the long- term, however, the scores of students in Group A have dropped more dramatically than Group B.

The results of the repeated measures ANOVA revealed that the term factor and grade are both significant (F[1,136] = 234.76; $P < 0.001$), with an effect size of η^2_p= 0.633 and (F[1,136] = 5.71; $P = 0.018$) with an effect size of η^2_p = 0.040, respectively. The term and grade interaction is also found significant with respect to the total scores (F[1,136] = 57.78; $P < 0.001$), with an effect size of η^2_p= 0.298.

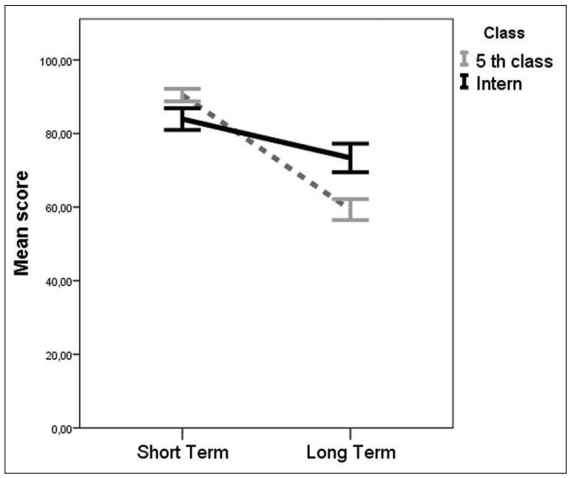

Figure 2: The endpoints of the lines represent the mean scores of each grade within each term, and the lines around the means represent 95% confidence intervals for the mean scores. The mean plot shows a significant interaction between term and grade and also decrease of total scores in the long-term for each grade

Table 2: The changes of content-related items on prescriptions with respect to terms for both grades

Prescription items	Grade	STA (+) LTA (+), *n* (%)	STA (+) LTA (–), *n* (%)	STA (–) LTA (+), *n* (%)	McNemar test* (*P*)
Diagnosis	Group A	42 (43.8)	51 (53.1)	1 (1)	<0.001
	Group B	31 (73.8)	3 (7.1)	6 (14.3)	0.508
Generic or trade name of drug	Group A	91 (94.8)	5 (5.2)	0	0.07
	Group B	42 (100)	0	0	1
Recommended dose	Group A	65 (67.7)	31 (32.3)	0	<0.001
	Group B	33 (78.6)	8 (19)	0	0.008
Strength and dosage form	Group A	28 (29.2)	62 (64.6)	0 (0)	<0.001
	Group B	28 (66.7)	10 (23.8)	4 (9.5)	0.180
Total amount to be delivered	Group A	36 (37.5)	49 (51)	4 (4.2)	<0.001
	Group B	29 (69)	2 (4.8)	11 (26.2)	0.022
Instructions and warnings	Group A	87 (90.6)	9 (9.4)	0	0.008
	Group B	41 (97.6)	0 (0)	0 (0)	1

Group A *n*=96; Group B *n*=42. STA=Short-term assessment, LTA=Long-term assessment, +=Present; –=Absent

Table 3: Descriptive statistics for total scores with respect to terms, grades and grades within terms and *post hoc* tests

Grade categories	Term categories	Mean±SD	Minimum; maximum	*P* adjusted (paired samples *t*-test)
5th grade (*n*=107)	Short (*n*=107)	90.43±8.90	54; 100	<0.001
	Long (*n*=97)	59.41±14.06	24; 91	
Interns (*n*=47)	Short (*n*=47)	83.91±10.03	54; 100	<0.001
	Long (*n*=43)	73.37±12.56	39; 92	

SD=Standard deviation

The evaluation of the prescriptions items

Each item in the prescription has a predefined score, as presented in Table 1, depending on its importance where each score constitutes the total score based on prescription scoring form to assess the theoretical concept of prescribing. The correlations of total scores between two assessments for the Group A and Group B students were 0.091 and 0.346, respectively.

The study results showed that the scores of the prescription components changed significantly after a year for each student group. The changes in crucial parameters of a prescription related to drug information are presented in Table 2. The prescription items were considered as format- and content-related items. For Group A students, the results of the McNemar test showed that the application of most of the items worsened significantly, except "name of drug" [Table 2]. On the other hand, for Group B, the results of the McNemar test showed that format-related items which are "name of the physician," "address of the physician," "date," and "presence of "Rp" and content-related items such as "diagnosis," "drug name," "total amount to be delivered," and "instructions" "did not show significant change, so these competencies showed continuity. However, the scores of some content related items which are "recommended dose" and "total amount to be delivered" and the format related items such as "patient's name," "age," "gender," "address," and "signature" significantly got worse after a year.

We also calculated point-biserial correlation analysis between each item on the prescription and both short- and long-term scores for all students. A year after the course, the students in Group A tend to exclude important items such as "diagnosis" and "strength and dosage form," while the students in Group B tend to exclude items such as "date" and "address" in the prescription.

Students' opinions and attitudes about prescribing

The results of the qualitative data in students' feedback form showed that most of them were pleased with the components of the program. They found that concepts learned in clerkship were useful in other clerkships they attended (Group A, 51.5%, and Group B, 67.4%). Majority stated that they feel confident to evaluate the concepts of rational pharmacotherapy (efficacy, safety, suitability, and cost) (Group A, 52.6%, and Group B, 60.5%). Group B students achieved self-confidence in making rational drug and/or nondrug treatment decisions in other diseases (62.8%). Most of the students stated that they applied p-drug selection method for other diseases and used their p-drug during their practice in other clerkships. Only 24.7% of Group A students applied the p-drug selection method for other diseases during treatment planning for patients. 53.6% of Group A students and 70% of Group B students expressed that they gained prescribing confidence. The students also declared that this rational pharmacotherapy course would be useful in their future professional lives (50.5% and 48.8% in Groups A and B, respectively).

The concomitant drug use and concomitant diseases were the most commonly considered parameters during drug selection, whereas patients' social security, age, and gender were the least commonly considered parameters. The sources for drug information that students used were similar in both the groups. The general Internet search engines were the most commonly used source for drug information. The pregnant population and pediatric population were the most difficult populations for students to regulate drug treatment. The consideration of efficacy, suitability, safety, and cost criteria during choosing drug was also similar between groups, and more than 95% in each group noted that they consider all criteria except for the treatment cost, which was considered more by Group B than Group A students (82% and 68%, respectively).

The expectations of the students regarding this course were as follows: both grade students stated that they want to discuss and apply p-drug selection for more different diagnoses and majority mentioned that they desire to attend this course in the scope of other clinical clerkships. They expressed to attend less lecture and more practical case discussions. All students also agreed that rational pharmacotherapy course should be a compulsory in the pregraduation period.

Discussion

The result of this study showed that a majority of the students were able to prescribe properly and the script scores of all students were high at the end of the course showing short-term efficacy of this training program. This is compatible with other randomized controlled trials showing the efficacy of this method.[9,15-17] However, total prescription scores are reduced even 1 year after the course in both the fifth- (Group A) and the final-year (Group B = interns) medical students. This decrease in total score was higher in students who attended the course in the 4th year of the school. The long-term retention effect of the course was found to be higher in students who attended the same course in the 5th year compared to attendants of the 4th year according to the scores.

The WHO Guide to Good Prescribing suggests the essential items that should be written in a prescription.[8] We evaluated these items by categorizing them as format- and content-related items. The

interns (Group B) who attended the course at the 5th year maintained most of the items in their prescriptions 1 year after the course. On the other hand, in most of the scripts of the students who attended the course at the 4th year, except only one item "drug name," any one of the other prescription components was missing 1 year later.

In long-term assessment, the recommended dose was present in 67.7% in fifth-grade students and 78.6% in interns. The dosage forms were present in 29.2% and 66.7% and instructions were present in 90.6% and 97.6% in Group A and Group B, respectively. Interns in the current study have better results than the findings of a study conducted with final-year medical students in Nigeria; 29.03% of the prescriptions did not include the dose units of the medication, 29.03% of the prescriptions missing the strength of the medication, and all the prescriptions were deficient in instructions for the patient.[18] In another study of prescriptions in pharmacy in Eritrea, prescriptions' format was analyzed and dose, frequency, and quantity and/or duration were present in 83.7%, 87.7%, and 95.1%, respectively.[19] In the study of Singh *et al.*, the correct dose and dosage was noted in 73.3% of the prescriptions of a hospital. In the same study, the diagnosis was mentioned in 64.2% of the prescriptions.[20] The interns in our study included diagnosis in 73.8% of the prescriptions, whereas fifth-grade students in 43.8%.

It is conceivable that the final-year interns can have more opportunities for making treatment plans and practicing prescribing more than the 5th-year students since they work actively in clinical environment. These findings are consistent with the importance of prescribing education in the later years of undergraduate training for the students, and it was reported that confidence of students in prescribing comes from practice and familiarity with a particular drug in the ward.[21-23]

In the script of the interns, the presence of correct name of the drug with appropriate drug selection, the recommended dose with instructions, and warning were correct in most of the prescriptions which are more crucial components of a prescription. However, the missing items were strength and dosage form and total amount to be delivered which are also crucial in a prescription, in addition to patient-related items such as demographical characteristics (age and gender). These items were related to the clinical experience through clerkships; thus, more practice with patients in outpatient clinical environment is needed. As the prescription practice is important to achieve the habits, increasing its practice during training sessions may help students to improve their decision-making and treatment planning for patient s.[9] This is consistent with the situation that the Group B students who attended the course at the 5th year are working actively in treatment planning and using the information that they had learned in the course. Despite declining in prescribing format scores, the improvement was not a temporary effect, since most of the items remained high a year on.

In our study, the selection of correct drug was present in approximately 95% in both the groups and in both short- and long-term assessments. The items related to drug information such as drug name, strength, and dosage form which indicates treatment planning are more important to evaluate since format-related items including patient information and physicians' information are available in electronic prescriptions. The worsening of crucial parameters such as drug information-related items was found to be lower in Group B intern students. The instructions and warnings about the drug were also complete in long-term assessment of Group B students. Furthermore, interns were unable to remember recommended dose and total amount to be delivered in long-term assessment when compared to short-term. We think that this is related to their knowledge and the use of basic pharmacology information. Having basic pharmacology knowledge and understanding the pathophysiology of the disease and risks and benefits of the medicine are required in order to write good prescription.[24] In a study, it was revealed that the most frequent poor performance of the medical students' prescriptions was found to be an inability to select the correct drugs and the organization of treatment plan assessed by objective structured prescribing examination.[25] Treatment planning and prescription writing are among the most challenging key competencies for a young medical student, and as it is a complex task involving pharmacological knowledge combined with patient communication, more practice is needed.[26]

The worse performance of the 5th-year students (Group A) is important and consistent with the opinions of the students declaring that they should make more practice in prescribing and also apply this p-drug selection method in other clinical clerkships as well. The use of this method in other clinical situations should be generalized in other clerkships to gain prescribing skills. This need is also expressed by the majority of the students. In our findings, 53.6% of Group A students and 70% of Group B students expressed that they gained prescribing confidence. In Geoghegan *et al.*'s study, the doctors 1 month before the completion of their internship stated that they felt confident in prescription writing (89%) and 28% of the participants expressed that their undergraduate medical education had prepared them for prescribing in clinical practice and it was associated with formal training in prescribing skills. In our study, a higher rate of interns (48.8%) found rational pharmacotherapy

course to be useful in their future professional lives.[27] This finding is consistent with the reports that real-life prescribing in clinics is mostly not performed.[7,28] These are the same with the findings of a study where the educational effects of final-year undergraduate program were investigated and perceived lack of knowledge and confidence in prescribing was noted.[27] In a study of U. K. medical students, even 5.7% of final-year students did not receive any practical prescribing teaching in their undergraduate training.[29]

The results of the qualitative data in students' feedback form showed that students of both the groups remembered what was learned (retention effect) even after 1 year. Students' perceptions regarding applying rational pharmacotherapy and prescribing in special populations such as pediatrics and pregnancy were evaluated, and students state that after 1 year, they can recognize and be able to incorporate it into their medical practice, though these special populations were the most difficult populations for them. Similar findings were reported by Chaudhari *et al*. that more than half of the interns supported that pregnant females should not consume any drug and two-third of the interns were confused about deciding the correct dose for pediatric patients.[30] The students in the current study use information that was learned in the course and can transfer it to other situations faced in other disciplines as reported in other studies.[9,10,15] This will contribute when repeated more frequently and when it is integrated to other clinical disciplines vertically through the medical curriculum, integrating with and identifiable within relevant horizontal modules.[31] In a study, it was suggested that undergraduate clinical pharmacology and therapeutic education should be changed to improve the prescribing of future doctors by making more emphasis on training in clinical practice.[23] In Chen *et al*.'s study where learner-centered student-run clinic feasibility was tested, students had an early prescribing experience, with real responsibility for patient care under senior clinician supervision.[32] In a study where a qualitative analysis was performed regarding the students' feelings of responsibility for real authentic tasks in student-run clinics, they expressed that it offered them learning opportunities and contributed to their learning.[33] Collectively, the practice of prescription writing should be performed in work-based environment and more frequently.[23,32-34] An authentic learning within the clinical work-based environment would be more effective than traditional lecture-based learning with regular prescribing practices.[23]

As shown by different studies, prescriptions without a format, with low legibility, and/or having incomplete medication orders are important problems that increase medication error risk and patient harm.[19] The competence in prescribing will contribute significantly to prevent prescribing errors. Although electronic prescriptions are in use today, it is not possible to assess the real-time prescribing performance of the students. Therefore, in order to evaluate the students' treatment planning, we used paper prescriptions.

This study was biased toward participants from one medical school. A large study that would include students from all medical schools would likely eliminate this bias. The prescription writing was assessed by one prescription audit. The performance of students should be assessed systematically throughout clinical education. A limitation of this study was that we could not be able to determine the need assessment of the groups in the beginning of the study, so we have just made a comparison between the groups related to short- and long-term educational effects. We think that the study should be designed to evaluate the retention effect between the comparable groups with the same learning needs in the future. The two cohorts are not comparable in terms of cognitive learning and experience. Therefore, the scores of postcourses and 1 year later were compared within each cohort by assessing cognitive development.

Conclusions

This study shows that the long-term retention effect of rational pharmacotherapy course on treatment planning conducted in later years of education is better than the course conducted in earlier years of education, which may be related to the fact that students in later years are more likely to be exposed to the clinical environment. To the best of our knowledge, this is the first work that shows the long-term effect of rational pharmacotherapy course by comparing two different grades of medical students showing the timing of this course in medical school programs that can be planned for later years of clinical periods in cases where it cannot be done as a longitudinal program. The prescribing with treatment planning and therapeutic knowledge of medical students can be enhanced by the use of longitudinal rational pharmacotherapy program in company by effective teaching methodology with pullulate with patient encounter in clinical education.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Brinkman DJ, Tichelaar J, Mokkink LB, Christiaens T, Likic R, Maciulaitis R, *et al*. Key learning outcomes for clinical pharmacology and therapeutics education in Europe: A modified Delphi study. Clin Pharmacol Ther 2018;104:317-25.

2. Brinkman DJ, Tichelaar J, Graaf S, Otten RH, Richir MC, van Agtmael MA. Do final-year medical students have sufficient prescribing competencies? A systematic literature review. Br J Clin Pharmacol 2018;84:615-35.
3. Maxwell SR, Cameron IT, Webb DJ. Prescribing safety: Ensuring that new graduates are prepared. Lancet 2015;385:579-81.
4. Velo GP, Minuz P. Medication errors: Prescribing faults and prescription errors. Br J Clin Pharmacol 2009;67:624-8.
5. Harding S, Britten N, Bristow D. The performance of junior doctors in applying clinical pharmacology knowledge and prescribing skills to standardized clinical cases. Br J Clin Pharmacol 2010;69:598-606.
6. Akıcı A, Gelal A, Erenmemişoğlu A, Melli M, Babaoğlu M, Oktay Ş. Evaluation of the status of the pharmacology departments in medical schools during the process of rational drug use training implementation in Turkey.Tıp Eğitimi Dünyası 2011;29:11-20.
7. Brinkman DJ, Tichelaar J, Okorie M, Bissell L, Christiaens T, Likic R, *et al*. Pharmacology and therapeutics education in the european union needs harmonization and modernization: A Cross-sectional survey among 185 medical schools in 27 countries. Clin Pharmacol Ther 2017;102:815-22.
8. De Vries TP, Henning RH, Hogerzeil HV, Fresle DA, WHO Action Programme on Essential Drugs. Guide to Good Prescribing: A Practical Manual World Health Organization; 1994.
9. Kamarudin G, Penm J, Chaar B, Moles R. Educational interventions to improve prescribing competency: A systematic review. BMJ Open 2013;3:e003291.
10. Akıcı A, Gören MZ, Aypak C, Terzioğlu B, Oktay S. Prescription audit adjunct to rational pharmacotherapy education improves prescribing skills of medical students. Eur J Clin Pharmacol 2005;61:643-50.
11. Hogerzeil HV, Barnes KI, Henning RH, Yunus E. Kocabasoglu YE, Möller H, *et al*. In: Hogerzeil HV, editor. Teachers' Guide to Good Prescribing. Geneva: World Health Organization; 2001.
12. Jakab M, Hawkins L, Loring B, Tello J, Ergüder T, Kontas M. Better non-communicable disease outcomes: Challenges and opportunities for health systems. Turkey Country Assessment. WHO Regional Office for Europe; 2014. Available from: http://www.euro.who.int/__data/assets/pdf_file/0011/248285/BetterNCDoutcomesChallengesOpportunitiesHealthSystemsTurkeyCountryAssessmentEng.pdf. [Last accessed on 2019 Dec 15].
13. Ulusoy HB, Sumak T, Şahin S, Gültekin H. The evaluation of a groningen model of pharmacotherapy training for general practitioners in Kayseri. Erciyes Med J 2011;33:309-16.
14. Faul, F, Erdfelder E, Lang AG, Buchner A. G*Power 3: A flexible statistical power analysis program for the social, and biomedical sciences. Behavior Research Methods 2007;39:175-91.
15. Keijsers CJ, Segers WS, de Wildt DJ, Brouwers JR, Keijsers L, Jansen PA. Implementation of the WHO-6-step method in the medical curriculum to improve pharmacology knowledge and pharmacotherapy skills. Br J Clin Pharmacol 2015;79:896-906.
16. Al Khaja KA, James H, Sequeira RP. Effectiveness of an educational intervention on prescription writing skill of preclerkship medical students in a problem-based learning curriculum. J Clin Pharmacol 2013;53:483-90.
17. Rissmann R, Dubois EA, Franson KL, Cohen AF. Concept-based learning of personalized prescribing. Br J Clin Pharmacol 2012;74:589-96.
18. Oshikoya KA, Bello JA, Ayorinde EO. Prescribing knowledge and skills of final year medical students in Nigeria. Indian J Pharmacol 2008;40:251-5.
19. Weldemariam DG, Amaha ND, Abdu N, Tesfamariam EH. Assessment of completeness and legibility of handwritten prescriptions in six community chain pharmacies of Asmara, Eritrea: A cross-sectional study. BMC Health Serv Res 2020;20:570.
20. Singh T, Banerjee B, Garg S, Sharma S. A prescription audit using the World Health Organization-recommended core drug use indicators in a rural hospital of Delhi. J Educ Health Promot 2019;8:37.
21. Coombes ID, Stowasser DA, Coombes JA, Mitchell C. Why do interns make prescribing errors? A qualitative study. Med J Aust 2008;188:89-94.
22. Brinkman DJ, Tichelaar J, van Agtmael MA, Schotsman R, de Vries TP, Richir MC. The prescribing performance and confidence of final-year medical students. Clin Pharmacol Ther 2014;96:531-3.
23. Linton KD, Murdoch-Eaton D. Twelve tips for facilitating medical students prescribing learning on clinical placement. Med Teach 2020;Feb 17:1-6.
24. Nazar H, Nazar M, Rothwell C, Portlock J, Chaytor A, Husband A. Teaching safe prescribing to medical students: Perspectives in the UK. Adv Med Educ Pract 2015;6:279-95.
25. James H, Al Khaja KA, Tayem YI, Veeramuthu S, Sequeira RP. Understanding preclerkship medical students' poor performance in prescription writing. Sultan Qaboos Univ Med J 2016;16:e203-9.
26. Ross S, Maxwell S. Prescribing and the core curriculum for tomorrow's doctors: BPS curriculum in clinical pharmacology and prescribing for medical students. Br J Clin Pharmacol 2012;74:644-61.
27. Geoghegan SE, Clarke E, Byrne D, Power D, Moneley D, Strawbridge J, *et al*. Preparedness of newly qualified doctors in Ireland for prescribing in clinical practice. Br J Clin Pharmacol 2017;83:1826-34.
28. Likic R, Vitezic D, Maxwell S, Polasek O, Francetic I. The effects of problem-based learning integration in a course on rational drug use: A comparative study between two Croatian medical schools. Eur J Clin Pharmacol 2009;65:231-7.
29. Kennedy MB, Williams SE, Haq I, Okorie M. UK medical students' perspectives on practical prescribing teaching and learning provisions: A cross-sectional survey. Eur J Clin Pharmacol 2019;75:1451-8.
30. Chaudhari VL, Mali SN, Dawari AV, Nishandar TB. Awareness about rational use of medicines among fresh bachelor of medicine and bachelor of surgery graduates. J Educ Health Promot 2017;6:94.
31. Brauer DG, Ferguson KJ. The integrated curriculum in medical education: AMEE Guide No. 96. Med Teach 2015;37:312-22.
32. Chen HC, Sheu L, O'Sullivan P, Ten Cate O, Teherani A. Legitimate workplace roles and activities for early learners. Med Educ 2014;48:136-45.
33. Schutte T, Tichelaar J, Donker E, Richir MC, Westerman M, van Agtmael MA. Clarifying learning experiences in student-run clinics: A qualitative study. BMC Med Educ 2018;18:244.
34. Dekker RS, Schutte T, Tichelaar J, Thijs A, van Agtmael MA, de Vries TP, *et al*. A novel approach to teaching pharmacotherapeutics-feasibility of the learner-centered student-run clinic. Eur J Clin Pharmacol 2015;71:1381-7.