

The Impact of Taking Math Courses on Nursing Students' Skills to Calculate Drug Dosages: A Comparative Study

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Abstract

BACKGROUND/AIMS: This study evaluated the impact of taking math courses on nursing students' skills to calculate drug dosages.

MATERIALS AND METHODS: Two different groups of undergraduate nursing students constituted the sample of this comparative descriptive study. The first group was composed of 66 students who attended a fundamentals of nursing course. The second group was composed of 70 students who attended a fundamentals of nursing course and a basic mathematics course after a change in the nursing curriculum. Data were collected using a personal information form and a drug dosage calculation skills test (DDCST).

RESULTS: Those students who attended the math course obtained significantly higher scores on the DDCST compared to those who did not attend the math course. Students who did not like math or had a lower cumulative grade point average received lower scores on DDCST.

CONCLUSION: These findings suggest that departments of nursing may cooperate with the faculty of education and include basic mathematics courses in the curricula of nursing departments to increase the abilities of nursing students to calculate drug dosages. New strategies may be developed to improve the mathematical skills of nursing students.

Keywords: Nursing students, nursing education, math course, drug dosage calculation

INTRODUCTION

Drug administration is one of the most important functions of nursing, and it requires technical skills and a comprehensive knowledge.^{1,2} Safe drug administration is one of the most important responsibilities of nurses.³ Therefore, nurses should have sufficient skills in medication safety and drug dosage calculations.⁴ Drug administration and medication safety are key subjects during the first year of nursing education.¹ Skills to calculate drug dosage are highly important for patient safety.⁵

Despite the development of new methods, tools and systems to ensure safety in drug administration, serious problems in drug administration

may still occur. Nurses and nursing students should have the mathematical skills to calculate the correct drug dosage in an effective and safe manner.⁶ Weaknesses in mathematical skills may harm patients via the miscalculation of drug dosages. Although the subject of drug dosage calculation is included in the nursing curriculum, problems with drug dosage calculation may occur in clinical practice. Weaknesses in mathematical skills are one of the main reasons for the miscalculation of drug dosages.^{3,7-9} Analysis of the curricula in different countries reveals examples of nursing undergraduate curriculum with courses on mathematics.¹⁰

Medication errors are the most common type of errors which affect patient safety. Nurses hold the responsibility to maintain patient safety

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during medication administration. They need to take the necessary measures in order to maintain patient safety and success in medication administration.¹¹ A study on Turkish nurses found that 66.6% of the nurses had witnessed at least one medication error during the prior 12 months.¹²

Recent studies have examined the miscalculation of drug dosage by nurses and attempted to reveal the reasons for these miscalculations. These studies evaluated the mathematical and drug dosage calculation skills of nursing students and stressed the importance of the development of these skills in nursing education.^{3,8,13} Some of these studies found that the nursing students had problems and felt anxious about basic math.¹⁴ Negative learning experiences of the nursing students influenced their mathematical skills, and so math education in small groups was proposed for undergraduate students in nursing departments.¹⁵

Correct drug calculation during clinical practice and the safe administration of medications are the most important qualifications for nurses. The education of nursing students using an appropriate curriculum is key for safe clinical practices. An analysis of the nursing curriculum in Turkish universities revealed the absence of basic math courses in nursing education. The student group who participated in this research was heterogeneous in math education. Math courses were added to the nursing curriculum due to the low success rates of the students in drug dosage calculations. The present study compared the drug calculation skills scores of nursing students who did not take the math course with those students who attended the math course, which was subsequently added to the nursing curriculum. This study revealed the effects of the introduction of a basic mathematics course to the nursing curriculum on the drug dosage calculation skills of nursing students. These study findings may contribute to the revision of the nursing curriculum in order to improve safe drug administration. Within this context, this study aimed to analyze the impact of math lectures on the drug dose calculation skills of nursing students. The research questions included the following:

1. Do math lectures have an impact on drug dose calculation skills of nursing students?
2. Is there a relationship between the descriptive characteristics of nursing students and their drug dosage calculation skills?

MATERIALS AND METHODS

The present study was a comparative descriptive study to evaluate the effects of a basic mathematics course on the drug dosage calculation skills of nursing students. This study was performed on first-year and second-year undergraduate students of the nursing department of a private university in North Cyprus. A total of 184 students, including 100 students who were enrolled in the fundamentals of nursing course during the 2016-2017 academic year and 84 students who took the same course during the 2018-2019 academic year after the amendment of the curriculum, constituted the population of this study. A total of 136 students who attended the course and agreed to participate in this research constituted the study sample.

This study was performed in the nursing department of the faculty of health services at a private university. The duration of the nursing undergraduate program at this university is four years. The department gives courses on social and basic medical sciences in addition to basic

nursing courses. Although the child health and disease nursing course in the third year also deals with drug dosage calculations, this subject is primarily the subject of the fundamentals of nursing course taught in the first year. The unit of the Fundamentals of Nursing course entitled "administrations of medications" includes 16 hours of instruction and teaches the basics of drug dosage calculation in approximately six hours.

Data Collection

This study was performed with undergraduate nursing students who had two different nursing curricula at the same university. Data were collected in two different periods, May, 2017 and December, 2018.

Group 1: Students in the first group took the fundamentals of nursing course in the spring semester of the first year. Drug dosage calculation was taught in approximately six hours within the context of the fundamentals of nursing course. Students were informed about the aim and scope of this research after their course, and their written consent was obtained. Students who agreed to participate were asked to complete the Drug Dosage Calculation Skills Test (DDCST) in 40 minutes without help or the use of calculators. Fourteen students who had not attended the lectures on drug dosage calculation and 20 students who found the test hard and left the study were excluded from this study. The study ultimately included 66 students in the first group.

Group 2: The nursing curriculum was amended in the 2017-2018 academic year, and a course, entitled Basic Mathematics for Social Sciences, was added. Unlike the first group, students in the second group took a basic mathematics course for 42 hours in 14 weeks during the first semester and took the fundamentals of nursing course after their basic mathematics course. The lectures on drug dosage calculation which were taught to the second group within the context of the Fundamentals of Nursing course did not differ from the first group. Ten students who had not attended the lectures and 4 students who refused to participate in this study were excluded. This study ultimately included 70 students in the second group.

Measures

We used a personal information form and the DDCST to collect the data.

Personal Information Form: This form was developed using the relevant literature^{1,16,17} and was composed of questions on the sociodemographic characteristics of the nursing students, including age, gender, and parental educational status.

Drug Dosage Calculation Skills Test: The DDCST was prepared by Karabağ Aydın and Dinç¹⁶ to evaluate the drug dosage calculation skills of nursing students. This test was prepared consistently with expert opinions, and item analysis was performed after a pilot study to evaluate the clarity of the test. The test included 25 questions, and each correct answer was given four points. The Cronbach's α of the DDCST was 0.67. We obtained permission to use the DDCST from the authors via e-mail.

Statistical Analysis

Frequency analysis was used to evaluate the distribution of the attendance to math courses according to the demographic characteristics of the participant students. The chi-squared test was used to compare the sociodemographic characteristics of the students who attended or did not attend the basic mathematics course. Means

and standard deviation were used to analyze the DDCST scores of the students. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to analyze the normality of the distribution of the DDCST scores, and the scores exhibited a non-normal distribution. Therefore, the Mann-Whitney U test was used for independent variables with two categories, and the Kruskal-Wallis test was used for independent variables with more than two categories.

Ethical Considerations

We obtained institutional permission from the head of the nursing department and research ethics approval from the research and publication ethics Eastern Mediterranean University Board of the university where this study was conducted (approval number: 2017/43-7). Written informed consent was obtained from all the participants.

RESULTS

Descriptive Characteristics of the Nursing Students

A total of 41.18% of the participants were between 18-19 years old, and 59.56% were female. The mothers of 32.35% of the participants and the fathers of 26.47% of the participants were graduates of primary school. A total of 40.44% of the participants were graduates of general high schools, and 60.29% were enrolled in nursing departments with an undergraduate placement exam. In addition, 30.88% of the participants had a cumulative grade point average (CGPA) lower than 2.00, and 35.29% had low success rates. Furthermore, 60.29% of the participants liked math. A total of 30.15% expressed that they did not use calculators, and 54.41% sometimes used calculators during mathematical calculations. A total of 44.85% of the participants considered themselves insufficient during drug dosage calculations.

Effects of the Math Course on DDCST Scores

The DDCST scores of those participants who had taken the basic mathematics course ($=50.69 \pm 19.91$) were significantly higher than those students who had not taken this course ($=12.24 \pm 11.74$) ($p < 0.05$) (Table 1).

Comparison of the Descriptive Characteristics of the Students using the DDCST Scores

Table 2 reveals no statistically significant differences between the age, parental education, type of high school and perceptions about the success of the students who had taken the basic mathematics course and their scores on the DDCST ($p > 0.05$). However, we found a statistically significant difference between the DDCST scores of those students who had taken the basic mathematics course and their gender, type of exams passed in order to enter the nursing department, academic success, calculator usage and their self-evaluations about their own drug dosage calculation skills ($p < 0.05$). Accordingly, the DDCST scores of the male nursing students were statistically higher than their female counterparts ($p < 0.05$). Students who had entered the nursing department using the

EMU Entrance Exam had lower DDCST scores ($p < 0.05$). Students with a CGPA below 2.00 obtained lower DDCST scores. However, students who liked mathematics and did not use calculators to solve mathematical problems had higher DDCST scores. Participants who considered their drug dosage calculation skills as sufficient also obtained higher DDCST scores.

DISCUSSION

Problems with drug dosage calculations have been on the agenda of researchers for a long time because miscalculations may harm patients.¹⁸ Nurses and nursing students should have sufficient mathematical skills to calculate correct drug dosages. Poor skills in basic mathematics results in the miscalculations of drug dosages.^{9,19} Our study found that the DDCST scores of those students who had taken a basic mathematics course were higher than for those who had not taken this course. In contrast to our findings, Alteren and Nerdal⁷ found that the scores obtained from a basic math course did not significantly affect drug dosage calculation skills. However, Karabağ Aydın and Dinç¹⁶ found a positive relationship between the arithmetic skills of nursing students and their DDCST scores. Similarly, Coyne et al.³ found that strategies to increase the mathematical skills of nursing students increased their drug dosage calculation skills. McMullan et al.²⁰ also found a statistically significant positive relationship between the mathematical skills of their participants and their drug dosage calculation skills. Røykenes and Larsen⁹ found that participants who perceived their mathematical skills as insufficient considered the drug dosage calculation tests stressful. Two studies on Turkish nursing students found that the mathematical and drug dosage calculation skills of their participants were low.^{5,21} The students in our study entered the nursing department using different entrance exams and they were graduates of different types of high schools. The students had different mathematical skills depending on their type of high school. Therefore, we suggest that students who did not take math courses may obtain lower scores from drug dosage calculation tests. The findings of this study reveal the need for an amendment to nursing curricula with the addition of basic arithmetic skills for the administration of medications.

The DDCST scores of the participants increased from 12.24% to 50.69% with the inclusion of the basic mathematics course to the nursing curriculum. The introduction of a basic mathematics course also influenced the scores obtained by the students on their final exams. The average final exam scores of the control group who did not take the basic mathematics course was 51 during the 2017-2017 academic year. The average final score increased to 61.06 during the 2018-2019 academic year after the introduction of the basic mathematics course. The average DDCST score of the nursing students in the study of Karabağ Aydın and Dinç¹⁶ was 71.55 ± 12.29 . The lower DDCST scores prior to the introduction of the math course in our study may have occurred due to a number of reasons. Nursing students should have obtained high scores from the math section of their university entrance exams, and so undergraduate students of nursing departments would have already

Table 1. Comparison of the drug dosage calculation skills test scores of those students who had taken and those who had not taken a math course

Group	n	\bar{x}	s	M	Min.	Max.	SO	Z	p
Took math course	70	50.69	19.91	54	12	84	97.54	-8.881	0.001*
Did not take math course	66	12.24	11.74	12	0	52	37.70		
Total	136	32.03	25.31	24	0	84	-	-	-

* $p < 0.05$.

Table 2. Comparison of the descriptive characteristics of students who had received the math course with their scores obtained from the drug dosage calculation skills test							
	n	\bar{x}	s	M	SO	χ^2/Z	p
Age							
18-19	24	44.50	20.74	40.00	29.44	3,627	0.163
20-21	32	53.25	17.04	56.00	37.47		
22 and above	14	55.43	23.21	62.00	41.39		
Gender							
Female	35	44.11	20.15	48.00	28.74	-2.787	0.005*
Male	35	57.26	17.59	64.00	42.26		
Maternal education							
Illiterate	16	56.00	14.68	62.00	39.84	6,845	0.144
Primary school	19	51.16	20.77	56.00	36.71		
Secondary school	8	57.00	28.02	66.00	43.56		
High school	21	48.57	18.60	48.00	33.02		
University or above	6	34.00	16.73	30.00	18.00		
Paternal education							
Illiterate	9	55.56	15.29	60.00	39.50	3,692	0.449
Primary school	19	53.47	21.34	64.00	39.11		
Secondary school	10	52.40	20.87	48.00	36.85		
High school	18	50.67	21.61	56.00	35.86		
University or above	14	42.57	17.79	42.00	26.61		
Type of high school							
General high school	28	47.71	22.12	50.00	33.18	2,021	0.568
Vocational high school	9	48.00	21.82	40.00	33.67		
Anatolian high school (elite high school)	28	52.29	18.25	52.00	36.41		
Other	5	63.20	6.57	68.00	46.70		
Type of university entrance exam							
Eastern mediterranean entrance exam	19	36.21	19.62	28.00	21.68	17,492	0.001*
Undergraduate placement exam	43	53.58	17.37	56.00	37.80		
Vertical transfer examination	8	69.50	9.06	72.00	55.94		
CGPA							
1.99 and below	23	40.52	20.55	40.00	25.63	8,526	0.014*
2.00-2.99	35	54.97	16.47	56.00	39.21		
3.00 or above	12	57.67	21.81	64.00	43.58		
Perceived success							
Low	21	47.24	19.50	48.00	31.52	2,143	0.342
Medium	45	51.29	20.40	56.00	36.34		
High	4	62.00	14.79	68.00	46.88		
Attitudes towards mathematics							
Likes	38	55.16	18.58	56.00	40.08	-2.058	0.040*
Does not like	32	45.38	20.41	48.00	30.06		
Usage of calculators							
Uses	12	38.33	21.81	34.00	23.58	10,613	0.005*
Does not use	17	61.65	16.19	68.00	47.76		
Uses occasionally	41	49.76	18.72	52.00	33.90		
Evaluation of drug dosage calculation							
Adequate	6	63.33	20.46	70.00	50.42	7,042	0.030*
Partially adequate	35	54.51	16.27	56.00	38.41		
Inadequate	29	43.45	21.77	48.00	28.90		

*p<0.05, **Super high school, college, private high school.

achieved a certain threshold of skills in math in Turkey. However, the students in the present study entered the nursing department using different entrance exams. A total of 27.14% of the students entered the department using the EMU entrance exam despite having lower math scores. The fact that this study was only performed on nursing students who received the fundamentals of nursing course may have influenced our findings because those students who took the pediatric nursing course received information on drug dosage calculations and gained more practice regarding this subject, which may have positively influenced their DDCST scores.

Our study found that the DDCST scores of the male participants were higher than the females ($p < 0.05$). However, another study of Turkish nursing students found no impact of gender on drug dosage calculation skills.⁵ A randomized controlled study to develop the drug dosage calculation skills of nurses found that male nurses had fewer miscalculations and benefited more from their education.¹⁸

Existing studies suggest that limited math experience leads to lower math scores and higher anxiety levels.⁹ Students with more math experience are better at drug dosage calculations.²² The participants in our study who liked math and had sufficient knowledge of drug dosage calculations obtained higher scores on the DDCST. Røykenes and Larsen⁹ found that those students who evaluated their math knowledge as low felt higher stress during drug dosage calculations. Various studies also stressed the relationship between drug dosage calculation skills and other factors, such as math skills and anxiety, in solving mathematical problems.³ Taking the findings in the literature into consideration, we may conclude that the DDCST scores of the nursing students who liked math are higher.

Study Limitations

Firstly, this study was only performed on students who took the fundamentals of nursing course. This factor constitutes a limitation because the pediatric nursing course, which also includes the subject of drug dosage calculation, may have influenced the results of our study. Secondly, we used classical methods to teach drug dosage calculations. The use of other methods to teach dosage calculation and randomized controlled trials may change the research findings, which constitutes the second limitation of the study.

CONCLUSION

Curricula for undergraduate nursing programs should be prepared in order to provide qualifications for nurses so that they may work in clinical environments and be prepared for life-long learning. Mathematical and drug administration skills of nursing students play a key role during their preparation for clinical practice. The administration of medications, which is highly important for patient safety, holds an important place in the nursing curriculum. Nursing educators should prepare a supportive environment for the students using different methods in order to increase the math skills of the nursing students. Continuous education should be maintained to develop the mathematical and drug dosage calculation skills of nursing students. We suggest that nursing curricula should be amended to improve the mathematical skills of the nursing students at the undergraduate level. In addition, we suggest that the basic math skills of the students who will study nursing should be improved before they enter the faculty.

MAIN POINTS

- Safe drug administration is one of the most important responsibilities of nurses.
- Skills to calculate drug dosage are highly important for patient safety.
- Students who attended a math course obtained significantly higher scores on the DDCST.
- Departments of nursing may cooperate with the faculty of education and include basic mathematics courses in the curricula of nursing departments.

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ETHICS

Ethics Committee Approval: We obtained institutional permission from the head of the nursing department and research ethics approval from the research and publication ethics Eastern Mediterranean University Board of the university where this study was conducted (approval number: 2017/43-7).

Informed Consent: Written informed consent was obtained from all the participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: S.C., H.F.K. Design: S.C., H.F.K., Supervision: H.F.K., Resources: H.F.K., S.C., Materials: S.C., H.F.K., Data Collection and/or Processing: S.C., H.F.K., Analysis and/or Interpretation: H.F.K., S.C., Writing: S.C., H.F.K., Critical Review: S.C., H.F.K.

DISCLOSURES

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