BMC Medical Education

RESEARCH

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Concept mapping teaching method and nursing education: a systematic review and meta-analysis

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Abstract

Background Concept map is a novel metacognitive approach in education that can improve critical thinking and decision making skills in students and nurses. Therefore, the current systematic review and meta-analysis was conducted aimed to determine the effect of the concept map approach in nursing education.

Methods The present systematic review and meta-analysis was performed to analyze the published studies in the no time limit until Sep. 2024 according to the PRISMA 2020 guideline. Articles related to the purpose of the study were obtained from MagIran, SID, ProQuest, PubMed, Scopus, and Web of science (WoS) databases, and Google Scholar search engine using relevant and validated keywords. Heterogeneity among studies was examined using the I^2 index and Egger's regression intercept was used to examine the publication bias.

Results In the initial search, 579 studies were found, of which finally 44 articles with a sample size of 1722 people in the intervention group, and 1712 people in the control group were included in the meta-analysis. As a result of combining the studies, the educational performance score in the intervention group increased more than the control group [95% confidence interval: (1.693 ± 0.194, $P < 0.001$)]. The results of the subgroup analysis showed that the positive effect of performing concept map is more in the nursing students than working nurses, although this result was not statistically significant ($P > 0.05$).

Conclusions The results of this study showed that the concept map has significantly increased the performance of nursing education. The results of this study can be considered by educational and therapeutic policy makers.

Keywords Nursing, Education, Systematic review, Meta-analysis

Introduction

As we move forward, nurses in the field of health care face more complex issues and problems that require critical thinking to make decisions [1]. Critical thinking enhances the nurse's clinical decision-making power in diagnosing the patient's needs and choosing the best nursing decisions and actions [2, 3]. This type of thinking is an important aspect of professional practice in nursing, midwifery, and health, which is considered essential for nursing functions, especially in clinical fields [4, 5]. As a matter of fact, critical thinking is an essential part of clinical decision-making and nurses'competency [6].

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Critical thinking is a cognitive process in which a person makes judgments and decisions by examining the reasons and analyzing the available information and drawing conclusions from them [7]. In other words, critical thinking is a purposeful, self-regulatory reflective judgment process that leads to the producing a logical solution to a problem and making appropriate decisions in the individual [8]. This is while the Conventional educational systems in universities deliver people with a lot of theoretical information to the society, but these people are unable to solve the small problems of the society in practice [9]. In fact, the traditional teaching method in universities conveys a mixture of information and theoretical concepts to students [10]. On the contrary, it does not convey to them the ability to analyze, prioritize and organize emerging knowledge, which is a requirement for critical thinking and will lead to effective and meaningful learning [11]. Therefore, to develop critical thinking, the role of educational centers as a reservoir of information and professors as speakers and transmitters of information should be changed [12]. On the other hand, instead of acquiring and retaining information, students should increase their thinking and reasoning skills and apply them in practice after processing the information [8].

Despite the importance of critical thinking, recent studies in educational and clinical environments have shown that nursing students largely lack appropriate critical thinking skills [13]. Traditional education methods all focus on a linear model of thinking [14]. Therefore, they cannot be used in the current complex educational environment. Meanwhile, the concept map is a new metacognitive approach in education that can improve the critical thinking and decision-making skills of students and nurses [15].

Concept map is one of the active teaching methods and a schematic and two-dimensional tool for presenting a set of concepts in the framework of propositions [16]. In fact, a concept map is a schematic presentation of the connection of one concept with another concept, as well as their connection with other concepts around a specific topic, which is arranged in a hierarchical pattern [17]. Knowledge that is learned in a meaningful way such as a concept map remains in the mind for a longer period of time, and improves critical thinking skills and problem solving ability in students and nurses [18].

Various studies have been conducted on the effect of the concept map approach in nursing education worldwide, there are inconsistencies in their results. These studies were conducted in small and limited populations and did not examine potential factors such as age, sample size, and population studied. Despite the importance of the topic, a wide search of studies and sources did not show any study that systematically examines the effect of the concept map approach in nursing education. Therefore, the current systematic review and meta-analysis was conducted aimed to investigate the effect of the concept map approach in nursing education in order to obtain a clear result. It is hoped that the systematic review of the studies will improve the critical thinking and decision-making skills of students and nurses.

Methods

The present systematic review and meta-analysis, which examined the impact of the concept mapping approach in nursing education, was conducted according to the PRISMA 2020 guidelines [19].

Search strategy

In this study, MagIran, SID, PubMed, ProQuest, Web of Science, Scopus, and Google Scholar databases were searched with the keywords "Conceptual Map", "Concept map", "Nursing" and their combinations. There was no restriction on the year of publication in this study, and all studies were reviewed without time limit until November 2023. In this regard, Medical Subject Headings (MeSH) were used. In order to search for studies, a search strategy defined for each database was used. In addition, a reference list of all found studies was manually searched to find additional studies. Searches were conducted in both Persian and English. The Persian equivalent of these keywords was used to search in internal databases. For example, the PubMed search strategy was defined as follows:

> (("Conceptual Map"[Title/Abstract]) OR ("Concept map"[Title/Abstract])) AND ((Nursing [Title/Abstract]) OR (Nursing [MeSH Terms]))

Study selection and data extraction

The inclusion criteria for the study were: interventional nature of the study, access to the full text of the article, having sufficient data to enter meta-analysis, and unrelated studies, observational studies, review articles, theses, case reports, letters to the editor, abstracts, and replicated studies were excluded from the analysis. Studies without a control group were also excluded from the study. Also, studies that had low scores on the JBI checklist were excluded from the study. According to the inclusion and exclusion criteria, the titles and abstracts of the articles were reviewed independently by two researchers, and relevant cases were separated and their full text was reviewed. In case of disagreement between the two researchers, it was resolved through discussion, and if no agreement was reached, a third person was consulted.

Risk of bias was assessed by two authors independently using the Cochrane Risk of Bias tool for allocation

sequence, allocation concealment, blinding, incomplete outcomes, and selective reporting in randomized controlled clinical trials and using the ROBINS-I tool in quasi-experimental studies.

Then, essential information about the articles, such as the name of the first author, year of publication of the article, sample size, location of the study, mean and standard deviation of the educational performance score before and after the intervention of the case group and the control group, the study population, and the qualitative assessment score, were recorded in a previously prepared form.

Qualitative assessment of studies

The Joanna Briggs Institute checklist was used to assess the quality of studies [20]. The JBI checklist has 13 different questions. For scoring, "Yes" was given if mentioned, "No" if not mentioned, and "NA" if not reported. The minimum and maximum scores based on the number of "Yes" were 0 and 13, respectively. Studies of high and moderate quality (score higher than 7) were included, although in the present study, there were no studies that scored less than 7 and were excluded from the study. The risk of bias was rated using a low, high, and unclear rating scale. The quality of studies was independently assessed by two authors (AF and ZHB).

Statistical analysis

In this study, the indicator investigated was the effect of the concept map approach in nursing education, which was used to combine the results of different studies from the mean and standard deviation of the intervention group and the control group in each study. The data were analyzed using Comprehensive Meta-Analysis software (CMA, Version 2.0, New England, NJ, USA). The standardized mean with a 95% confidence interval was calculated as the effect size. In the present study, the heterogeneity of studies was analyzed using the I2 index, and an I2 index of less than 50% was considered as"low heterogeneity"and greater than 50% as"high heterogeneity". Subgroup analysis and meta-regression were used to further investigate the source of heterogeneity. Egger's regression intercept was used to examine publication bias. The significance level was set at 0.05.

Results

Summary of how the articles were included in the meta-analysis

Using search strategies in different databases, a total of 579 studies were found, and 210 duplicate and overlapping studies were excluded. After checking the titles and abstracts, 316 studies were excluded due to lack of relevance to the topic of the study. Then, the full text of the remaining 53 studies were carefully examined, of which 9 studies were excluded due to not meeting all the inclusion criteria. Therefore, 44 articles related to the inclusion criteria were included in the meta-analysis. The steps of the PRISMA 2020 flow diagram are depicted in Fig. 1.

Summary of the characteristics of included studies

The total sample size of all articles included in the study was 1722 people in the intervention group and 1712 people in the control group. The oldest study was from 2005 and the most recent study was from 2022. The spectrum of the qualitative assessment of the studies based on the JBI checklist was between 9 and 13. The characteristics and data of the articles included in the systematic review and meta-analysis are presented in Table 1.

Meta-analysis of the standardized mean difference before and after the intervention in two intervention and control groups

According to the results of the meta-analysis, there was a lot of heterogeneity between the studies ($I^2 = 95.58$), therefore, the random effects model was used to combine the studies and the final results. As a result of the combination of studies, the score of education effect in the intervention group showed a significant increase of 1.693 ± 0.194 (CI: 95%) more than the control group, which was statistically significant ($P < 0.001$). Forest plot (Fig. 2) shows the estimate obtained by combining all studies and the standardized mean difference in each study. The 95% confidence interval is shown by the horizontal line of each square (Fig. 2). According to the results of Egger's regression intercept shown in Fig. 3, there was a publication bias in the studies at the 0.01 level ($P < 0.01$). The results of the sensitivity analysis showed that the final result does not change significantly by removing any of the studies (Fig. 4).

Meta-regression

Meta-regression in this study was used to investigate the relationship between potential factors such as the year of study (Fig. 5) and sample size (Fig. 6) with the standardized mean difference before and after the intervention in the control and intervention groups. The results showed that the relationship between the year of the study and the sample size with the mean difference before and after the intervention in the control and intervention groups was not significant ($P > 0.05$), (Figs. 5 and 6).

Subgroup analysis

Considering the high heterogeneity among the studies, subgroup analysis was performed according to the study population. The results showed that the positive effect of

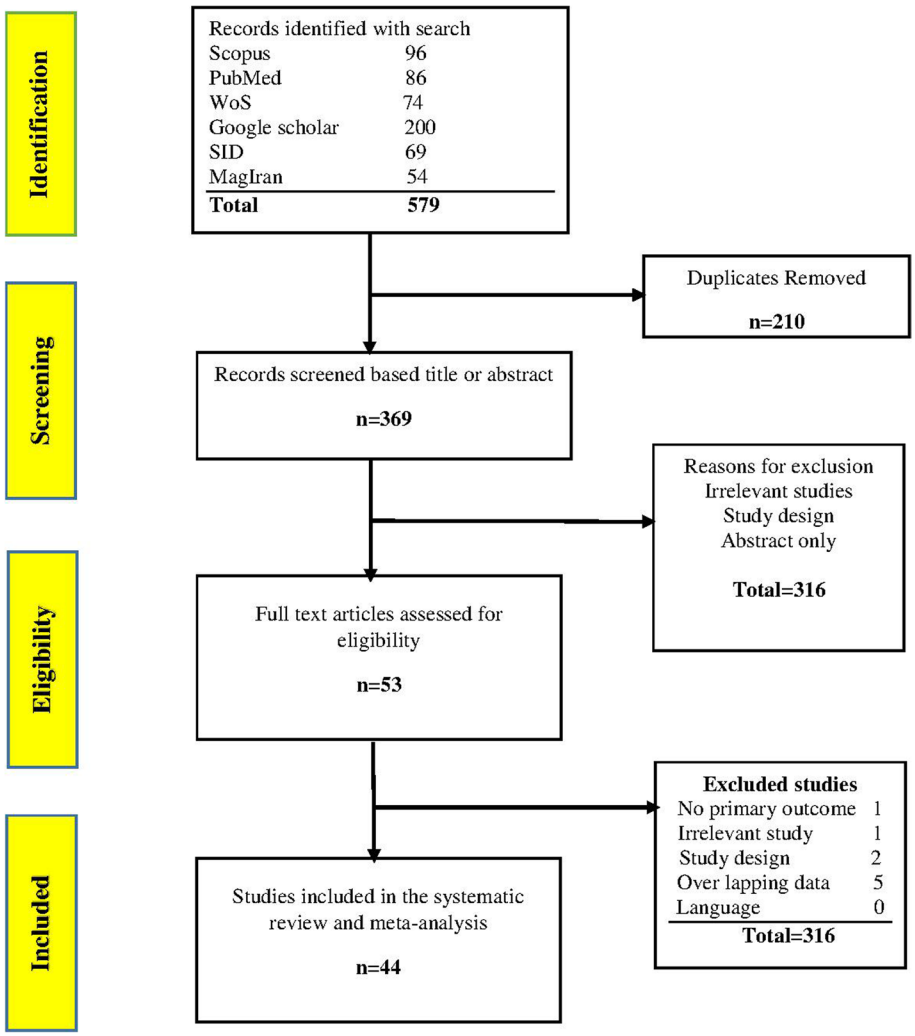

Fig. 1 PRISMA 2020 flow diagram of the present study

the intervention was greater in the population of nursing students than in the group of nurses, but the difference between the two groups was not statistically significant ($P > 0.05$), (Table 2).

Discussion

The present study was conducted aimed to determine the effect of the concept map approach in nursing education using the systematic review and meta-analysis methods. After combining the data from 44 reviewed articles, the results showed that the educational performance in the intervention group increased significantly more than the control group, which indicates the positive effect of using the concept map approach in nursing education. The systematic review and meta-analysis study by Yue et al., [61] has also shown the positive effect of the concept map approach in nursing education, which is consistent with the present study. The slight difference with the results of this study may be due to the number of articles included in the meta-analysis (11 articles versus 48 articles), and the fact that a relatively considerable number of studies included in the present study were conducted after 2017. The results of the present study showed that the use of the concept map model can significantly impact the teaching process outcomes, particularly in enhancing learning among nursing students and nurses. The findings of various studies also indicate this effect [35, 41, 57, 60]. In the study by Chen et al., the use of the concept map model significantly influenced critical thinking and learning in students [28]. Similarly, in the study by Dehghanzadeh, the use of this model had a significant effect on the teaching and learning process of nursing students [58]. Additionally, in another study, this model had a significant impact on the critical thinking skills of nurses and led to improvements in the design of nursing care for patients [57].

Table 1 Characteristics and data of articles included in systematic review and meta-analysis

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Rahmani et al., 2005 [21]	Iran	45	45	15.41 ± 2.12	24.5 ± 3.45	13.28 ± 3	23.12 ± 7.07	11	Nursing Students	The results showed that concept mapping had a positive effect on nursing education
Boyadjian-Samawi, 2006 [22]	USA	45	45	12.09 ± 5.67	21.87 ± 5.97	15.22 ± 6.36	33.13 ± 7.13	10	Nursing Students	The findings of this study suggest that concept mapping triggers critical thinking, which guides the student to engage in meaningful learning
Rahmani et al., 2007 [23]	Iran	24	21	8.33 ± 3.5	7.47 ± 2.64	9.29 ± 3.38	9.84 ± 2.7	9	Nursing Students	Considering the effect of concept mapping method on students' meaningful learning, it is recommended to employ this method in teaching courses which require a deep learning and high level of understanding the content
Molaison et al., 2009 [24]	UK	52	50	755 ± 24	764 ± 25	850 ± 27	764 ± 23	12	Nursing Students	Overall students' perceptions of concept mapping as a teaching–learning method were more positive than the preceptors' perceptions
Sarhangi et al., 2010 [25]	Iran	33	33	9.6 ± 3.83	11.93 ± 1.9	5.69 ± 2.23	12.3 ± 1.62	11	Nursing Students	Using concept mapping in the education of nursing students may lead to develop critical thinking skills as one of the important duties of higher education

Table 1 (continued)

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Sarhangi et al., 2011 [25]	Iran	33	33	2.24 ± 1.27	2.42 ± 1.17	2.64 ± 1.65	7.45 ± 2	9	Nursing Students	Concept mapping method is more effective to access meaningful learning and high levels of understanding than lecture method
Nejat et al., 2011 [26]	Iran	25	28	24.48 ± 6.54	27.09 ± 5.36	25.1 ± 5.77	28.41 ± 5.49	11	Nursing Students	Using concept maps can lead to deep and meaningful learning in nursing students
Sarhangi et al., 2011 [27]	Iran	33	33	2.64 ± 1.65	3.84 ± 1.25	2.24 ± 1.27	4.18 ± 1.26	12	Nursing Students	Using concept mapping in the education of nursing students may lead to develop critical thinking skills as one of the important duties of higher education
Chen et al., 2011 [28]	Taiwan	48	47	6.04 ± 2.24	5.44 ± 2.13	5.48 ± 2.29	6.09 ± 2.1	10	Nursing Students	This article provides that outcome-based concept mapping as educational method could encourage a group of nursing students to take a bio-psycho-social approach to medicine
Masoumy et al., 2012 [29]	Iran	33	33	11.87 ± 2.48	16.9 ± 5.18	15.3 ± 5.4	32.21 ± 2.81	9	Nursing Students	Both methods are effective ways to improve learning and retention scores in nursing students but concept mapping method is more effective
Abdoli and Khajeh Ali, 2012 [30]	Iran	21	20	11.85 ± 1.95	11.15 ± 3.93	11.61 ± 2.37	14.17 ± 3.84	10	Nursing Students	Even though it is impossible to draw a definite conclusion due to sample size and time Limitation

Table 1 (continued)

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Ojian et al., 2012 [31]	Iran	60	60	82 ± 32	73 ± 24	138 ± 20	223 ± 37	11	Nurses	According to the effectiveness of conceptual mapping methods in improving the leadership style of head nurses, we recommended using this method for management development or managers training
Atay and Karabacak, 2012 [32]	Turkey	40	40	221 ± 19.0	247.3 ± 16.4	220.0 ± 17.7	225.8 ± 19.2	9	Nursing Students	There were significant differences between concept map care plan evaluation criteria mean scores of the experimental students. In the light of these findings, it could be argued that the concept mapping strategy improves critical thinking skills of students
Moattari et al., 2013 [33]	Iran	16	16	15.86 ± 1.17	20.14 ± 1.63	15.83 ± 0.8	23.68 ± 2.58	9	Nursing Students	Teaching and application of clinical concept mapping leads to improvement of critical thinking abilities in nursing students
Habibzadeh et al., 2013 [34]	Iran	20	20	8.40 ± 1.57	9.05 ± 1.71	8.55 ± 2.31	12.15 ± 3.45	11	Nursing Students	Due to the effectiveness of concept mapping teaching methods in learning and performance of the students
Lee et al., 2013 [18]	Taiwan	48	47	41.93 ± 5.03	39.66 ± 6.93	41.26 ± 5.57	41.57 ± 4.71	10	Nursing Students	Concept mapping is an effective tool for improving students' ability to think critically

Table 1 (continued)

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Akbari et al., 2014 [35]	Iran	25	25	44.22 ± 8.6	52.5 ± 7.6	48.36 ± 8.89	71.12 ± 9.27	10	Nurses	This study revealed that the concept mapping strategy had a significant effect on the clinical decision making skills of nurses
Salmani et al., 2015 [36]	Iran	30	30	4.86 ± 1.85	10.67 ± 1.76	5.03 ± 1.46	12.83 ± 2.37	12	Nursing Students	Presenting the course content as conceptual map in mobile phone environment positively affects the significant learning of the nursing students
Rasoulzadeh et al., 2015 [37]	Iran	35	35	23.8 ± 2.26	23.5 ± 2.92	24.5 ± 2.54	77.9 ± 2.62	10	Nursing Students	Concept mapping was superior to conventional skill teaching methods. It is suggested to use concept mapping in teaching practical courses such as fundamentals of nursing
Sadeghi-a et al., 2016 [38]	Iran	35	35	3.3 ± 1.43	2.44 ± 1.26	3.60 ± 1.48	9.7 ± 2.66	10	Nursing Students	Using concept mapping strategy in the education of nursing students may lead to developing critical thinking skills as one of the important missions of higher level education
Sadeghi-b et al., 2016 [39]	Iran	35	35	3.30 ± 1.43	3.8 ± 1.48	3.6 ± 1.48	5.9 ± 1.84	10	Nursing Students	Using concept mapping strategy in the education of nursing students may lead to developing critical thinking skills as one of the important missions of higher level education

Table 1 (continued)

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Kaddoura et al., 2016 [17]	USA	42	42	81.1 ± 4.9	83.7 ± 5.5	79.59 ± 4.3	88.0 ± 4.8	9	Nursing Students	Students in the concept mapping group performed much better on the Health Education Systems, Incorporated than students in the control group
Hsu et al., 2016 [40]	Taiwan	106	104	217.4 ± 37.1	234.32 ± 29.6	221.4 ± 32.9	231.7 ± 27.3	9	Nursing Students	Our study suggested that concept map is a useful teaching strategy to enhance student critical thinking
Mohamed et al., 2017 [41]	Egypt	30	30	6.53 ± 1.67	5.60 ± 2.25	5.83 ± 2.30	9.60 ± 2.45	9	Nursing Students	It can be concluded that, students who were taught with concept mapping showed an increase in their CT scores, than those in the control group and thus, supported the study hypotheses
Zare and Kargar, 2017 [42]	Iran	16	15	3.33 ± 1.5	3.96 ± 1.02	6.91 ± 2.93	11.83 ± 2.84	10	Nurses	According to the results of the present study, the concept map strategy as an instruction is useful in active learning and also can be implemented in the nursing process
Ramazani et al., 2017 [43]	Iran	32	32	15.16 ± 1.27	15.6 ± 1.32	14.64 ± 2.29	15.24 ± 2.45	11	Nursing Students	Since the concept mapping method was more effective than the other two methods in students' achieving higher levels of learning and meaningful learning,

Table 1 (continued)

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Momeni et.al., 2017 [44]	Iran	16	16	253.61 ± 25.28	263.88 ± 22.15	252.17 ± 22.14	266.26 ± 23.45	10	Nursing Students	The results of this study shows that critical thinking disposition score in most of nursing student was uncertain
Abdi and Seyyed Mazhari, 2017 [45]	Iran	29	28	1.51 ± 1.27	6.1 ± 1.04	1.92 ± 1.15	6.82 ± 0.47	13	Nursing Students	In this study, there was no statistically significant difference between teaching methods based on concept mapping and lecture regarding meaningful learning (higher levels of knowledge) of BLS
Aein and Aliakbari, 2017 [46]	Iran	30	30	2.3 ± 0.53	2.3 ± 0.47	2.4 ± 0.77	2.5 ± 0.62	10	Nurses	Our findings support that concept mapping can be used as a clinical teaching–learning activity to promote CT in nursing students
Sadeghi-Gandomani, 2017 [38]	Iran	35	35	3.3 ± 1.43	3.8 ± 1.48	3.6 ± 1.48	5.9 ± 1.84	11	Nursing Students	
Mirzaee and Karimi, 2018 [47]	Iran	30	30	27.73 ± 2.63	23.66 ± 2.58	27.33 ± 2.63	68.63 ± 7.54	9	Nursing Students	The Conceptual map is a new method that haemovigilance education through it increases the awareness of nursing students and reduces the complications of improper use of blood products in patients

Table 1 (continued)

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Ranjbar-Delbaret al., 2018 [48]	Iran	34	34	17.45 ± 3.6	18.07 ± 2.6	17.83 ± 6.2	18.93 ± 2.5	11	Nursing Students	The implementation of nursing process with concept map leads to increasing the self-efficacy of learners in clinical practice
Raesi et al., 2018 [49]	Iran	75	75	35.07 ± 3.93	36 ± 4.49	34.33 ± 4.98	39.33 ± 3.83	10	Nurses	The leadership development program based on concept-mapping method could affect the leadership styles and improve the leadership style score
Abd El-Hay et al., 2018 [50]	Egypt	30	30	16.7 ± 2.1	25.0 ± 4.3	6.7 ± 1.6	73.3 ± 1.5	11	Nursing Students	Based on the findings of the study, there were significant improvement in the score of knowledge, simulation case study rubric and problem solving skills post application of concept mapping in the clinical setting
Alfayoumi, 2019 [51]	Iran	20	20	1.37 ± 0.64	1.53 ± 0.73	1.9 ± 0.66	2.18 ± 0.61	11	Nursing Students	Combining concept-based learning and concept mapping teaching techniques has a significant impact on nursing students'clinical reasoning abilities
Mohammadi et al., 2019 [52]	Iran	40	41	1.94 ± 1.03	3.77 ± 0.77	2.11 ± 0.93	3.65 ± 0.93	11	Nursing Students	Concept mapping was found to be an effective approach for improving students'critical thinking skills

Table 1 (continued)

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Roshangar et al., 2020 [53]	Iran	27	28	11.15 ± 2.3	14.33 ± 3.5	11.4 ± 1.78	15.75 ± 3.1	10	Nursing Students	Using integrative education methods such as conceptual mapping in combination with case-based education had a significant effect on enhancing student's critical thinking and academic self-efficacy
Amaniyan et al., 2020 [54]	Norway	80	80	8.85 ± 2.59	16.83 ± 1.58	9.01 ± 2.19	18.84 ± 1.18	9	Nursing Students	The conceptual map method had a statistically significant impact on the students' learning in the intervention group compared with the control group in the students with a visual learning style. No statistically significant differences were reported between the groups in other three learning styles
Khrais and Saleh, 2020 [55]	Jordan	60	55	5.89 ± 3.99	6.21 ± 3.76	7.2 ± 4.2	11.37 ± 6.61	9	Nursing Students	This study supports the usefulness of concept maps as a teaching strategy to promote development of nursing students' critical thinking abilities
Mahmoud et al., 2021 [56]	Egypt	85	85	20.1 ± 2.3	75.6 ± 3.6	15.6 ± 2.3	84.4 ± 3.1	12	Nursing Students	Mapping skill intervention improved the nursing students'achievements in pediatric nursing course compared with traditional nursing education

Table 1 (continued)

First Author, Year, (Reference)	Place of study	Sample size (n)		Mean ± SD Control group		Mean ± SD Intervention group		Quality score (Number "Yes")	Population	Results
		Control group	Intervention group	Before	After	Before	After			
Dehghanzadeh and Moaddab, 2021[57]	Iran	42	42	12.67 ± 2.41	12.94 ± 2.16	7.09 ± 2.76	15.4 ± 2.10	9	Nursing Students	The findings suggest that concept mapping is effective to strenghten students ' analysis and inductive reasoning of critical thinking and designing nursing care plan
Dehghanzadeh, 2021 [58]	Iran	40	44	144.7 ± 14.5	148.03 ± 14.55	141.1 ± 13.5	172.27 ± 10.02	10	Nursing Students	The present study suggests concept mapping as an effective method in clinical education of nursing students
Aghaei et al., 2022 [59]	Iran	34	35	9.13 ± 3.01	8.86 ± 2.71	10.13 ± 2.18	13.13 ± 2.13	13	Nurses	Based on the obtained results, the virtual training method was more effective than the concept map method in achieving the goals in the domain of knowledge
Khalili et al., 2022 [60]	Iran	53	50	19.57 ± 3.88	33.55 ± 4.01	18.8 ± 3.02	39.46 ± 3.23	10	Nursing Students	Both educational methods are effective in raising the learning efficacy of students

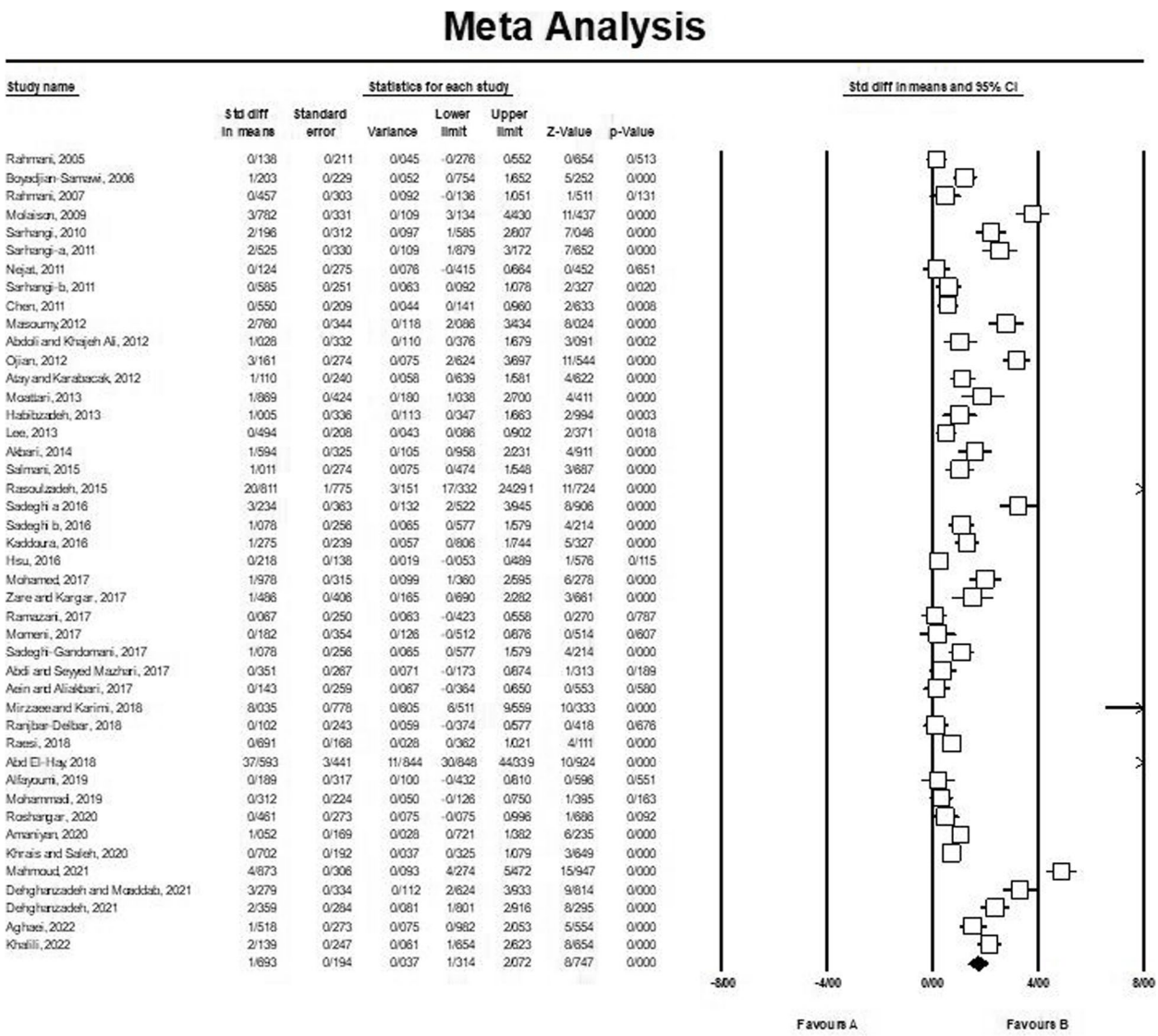

Fig. 2 Forest plot of the studies included in the meta-analysis before and after the intervention in the control and intervention groups

In explaining the results, it can be said that the use of the concept map model can enhance the understanding of concepts and their relationships among learners [62]. It improves critical thinking [13] and clinical reasoning in learners [63] and enriches learning experiences [64]. Furthermore, utilizing this model in teaching can facilitate conditions for active learning [65].

The meta-regression results showed that with the increase in the year of conducting the study, the effect of the intervention also has an upward trend. Although this result was not statistically significant, it was probably due to the development of educational methods in universities and medical training centers for students and nurses, an increase in the literacy level of healthcare personnel, and an increase in educational facilities and equipment.

Egger's test indicated bias ($P < 0.01$), this may be due to the lack of searching databases in different languages. Therefore, it is suggested that further studies should search all databases in different languages.

The results of the subgroup analysis showed that the positive effect of the intervention was greater in the population of nursing students than in the group of nurses. Because students are in the middle

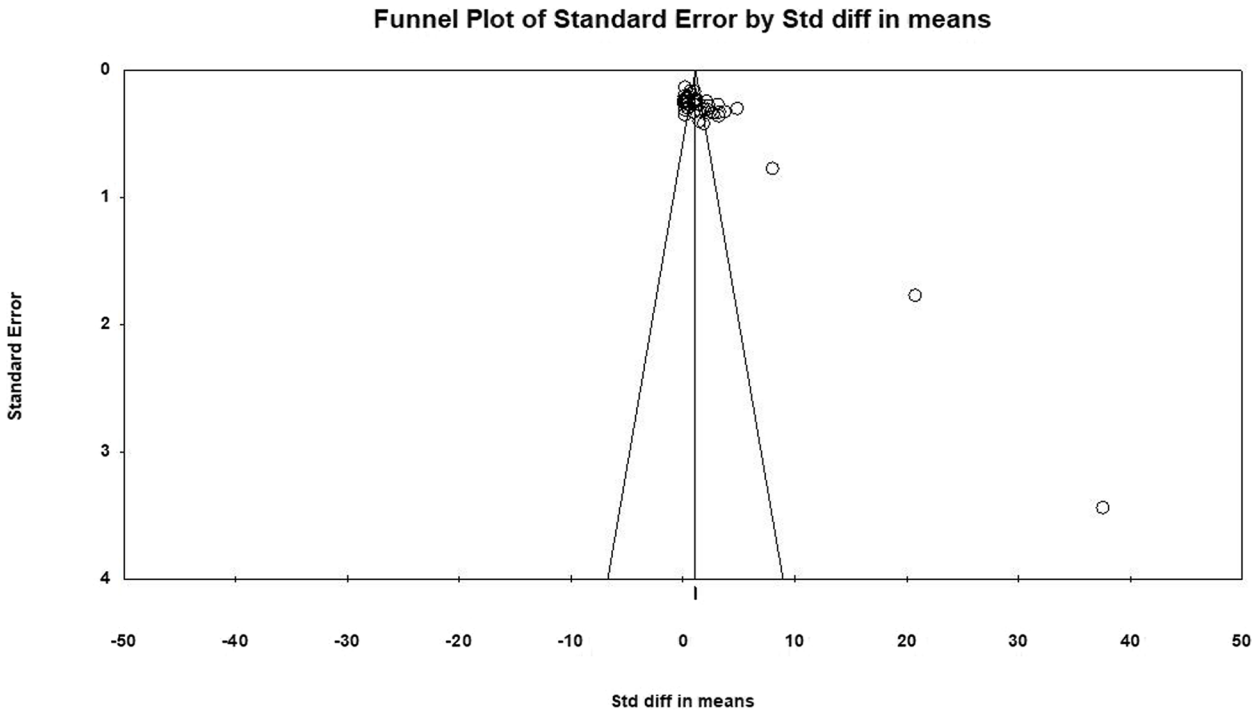

Fig. 3 Funnel plot of the studies included in the meta-analysis before and after the intervention in the control and intervention groups

of their studies and usually have no other job than studying, but nurses are usually more busy and may have other responsibilities such as wife and father/mother roles, so nurses show less interest in learning than students. Academic progress of students requires having a positive attitude towards the field of study and strong motivation. The attitude towards the field of study is apparently considered an individual matter. This is while the educational attitude from the perspective of psychology and sociology has a wide social dimension in addition to individual components. Among the social factors, we can mention the social environment, surrounding people, parents, teachers and other groups that are effective in creating, cultivating and consolidating positive or negative attitudes towards the field of study in students [66].

In today's advanced world, one of the indicators of a person's success is academic progress, without which the development of any country will not be possible [67]. The development of any country is directly related to its progress of science, knowledge and technology, and scientific progress cannot be achieved unless people with creative thinking are trained. Academic progress is both effective in the development of the country and at smaller levels leads to finding a suitable job and position, and as a result, sufficient income [68]. Productivity and improving the quality of the education system are among the most influential factors in the development of countries. The experiences of developed countries such as Japan in the field of comprehensive development also emphasize investment in educational and human resources [69].

Strengths and limitation

One of the strengths of the study was estimating the extent of the standardized mean difference before and after intervention in control and intervention groups by reviewing 48 published papers for the first time. One of the limitations of this study was the high heterogeneity in the studies (more than 90%). This heterogeneity forced us to use meta-regression based on potential factors such as publication year and sample size, as well as subgroup analysis based on the study population, which resulted in some reduction of heterogeneity, but still high heterogeneity within subgroups, Which may be due to cultural factors and educational contexts. Other limitations include the lack of identical reporting of articles, the non-random selection of samples in some studies, the lack of uniform execution method, and the lack of full text of articles presented at the conference.

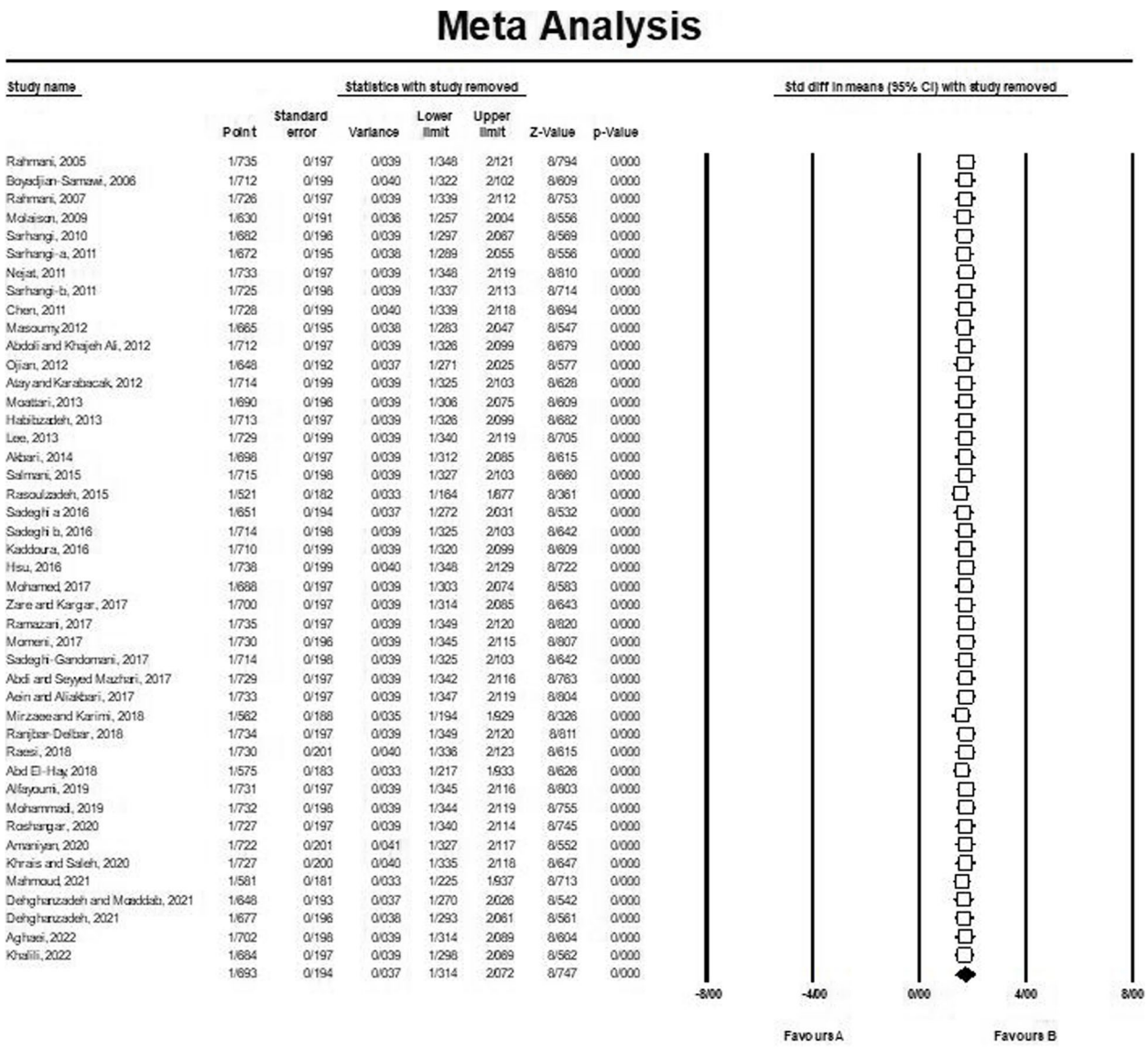

Fig. 4 Sensitivity analysis chart before and after intervention in control and intervention groups based on random effects model

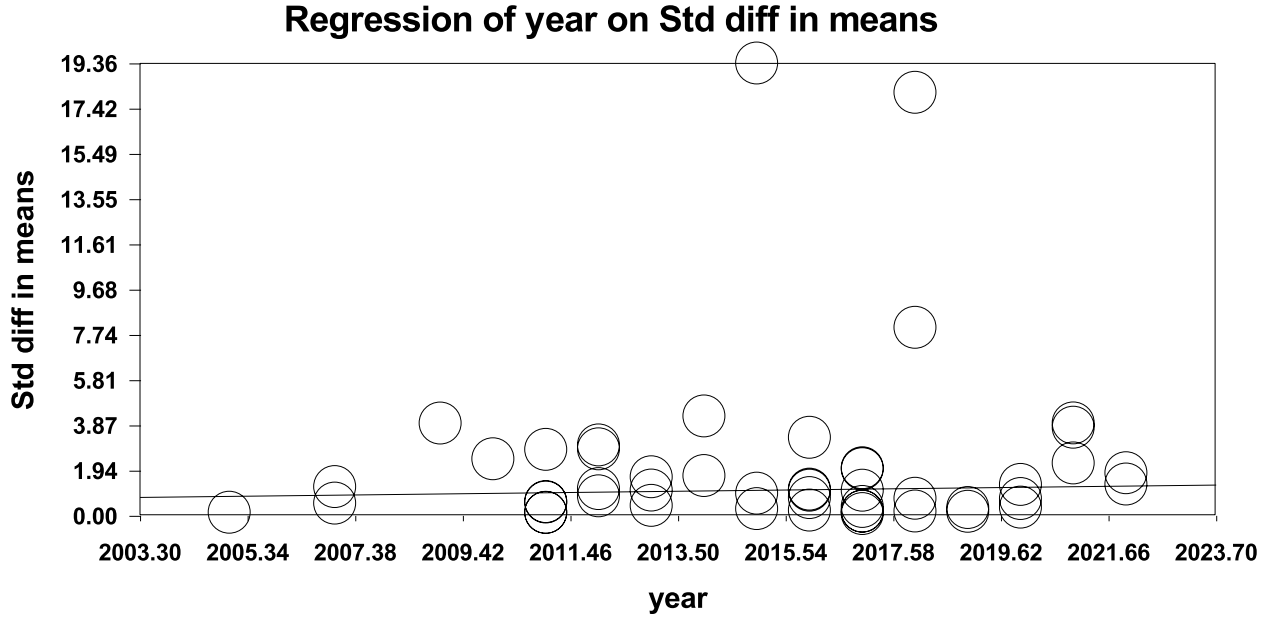

Fig. 5 Meta-regression of the relationship between the year of the study and the standardized mean difference before and after the intervention in the control and intervention groups

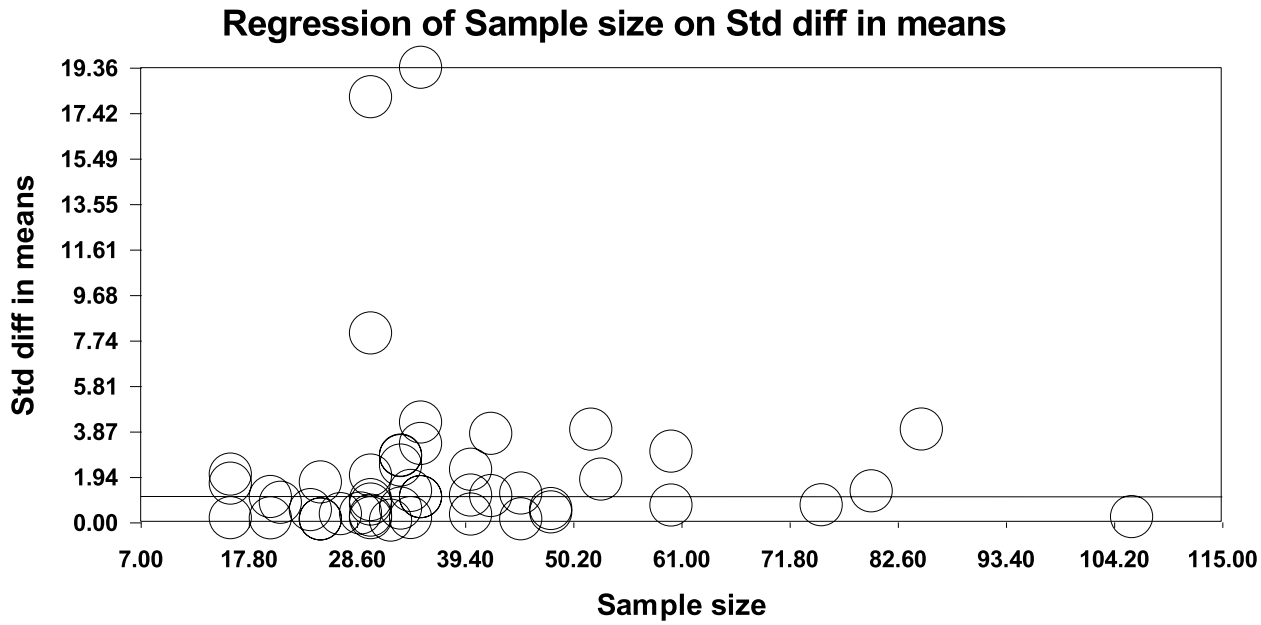

Fig. 6 Meta-regression of the relationship between the sample size and the standardized mean difference before and after the intervention in the control and intervention groups

Table 2 Subgroup analysis based on the study population

Subgroup	Number Studies	Point estimate	Standard error	*P*-value	*P*-value	I^2
Nurses	6	1.48	0.42	0.000	0.574	93.35
Nursing Students	38	1.75	0.20	0.000		95.63

Conclusion

The results of this study showed that the concept map has significantly increased the performance of nursing education. Although the present study has limitations such as high heterogeneity among studies, it can be considered by educational and therapeutic policy makers. The results of this study can provide valuable insights into improving nursing pedagogy, enhancing student learning outcomes, and preparing competent nursing professionals for their future roles in healthcare.

Abbreviations

WoS	Web of Science
MeSH	Medical Subject Headings
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
JBI	Joanna Briggs Institute

Acknowledgements

This study is the result of research approved by the Student Research Committee of Kermanshah University of Medical Sciences (50003263). We would like to thank the esteemed officials of that center for accepting the financial expenses of this study.

Clinical trial number

Not applicable.

Authors' contributions

A.F and A.J contributed to the design, R.J, A.F, Z.B and A.J participated in most of the study steps. A.J and R.J prepared the manuscript. A.J and A.F assisted in designing the study, and helped in the, interpretation of the study. All authors have read and approved the content of the manuscript.

Funding

Not applicable.

Data availability

The data analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The present study was approved by the Ethics Committee of Kermanshah University of Medical Sciences (IR.KUMS.REC.1402.270). In order to conduct this study, all the ethical issues of the Declaration of Helsinki were observed from the search for articles to the publication of the results.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 28 February 2025 Accepted: 22 May 2025
Published online: 28 May 2025

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