Systematic Review

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Educational intervention to improve preclinical academic performance: A systematic review

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Abstract:

INTRODUCTION: One of the major problems of higher education centers is the students' academic failure. Increased monitoring, counseling, or remediation may tax the resources of both the program and the faculty. The present review study gathered evidence highlighted by the experimental studies on the educational intervention with the purpose of improving preclinical medical performance.

MATERIALS AND METHODS: To achieve the intended studies, databases of PubMed, Web of Knowledge (Thomson Reuters), Educational Resources and Information Center, and the Scopus were searched. The inclusion criteria were being an interventional study and assessing the educational intervention to preclinical academic performance. The study was carried out as a systematic literature search published between January 1987 and January 2018. Based on valid tool through the best evidence medical education review, after assessing the quality of the studies.

RESULTS: Ten studies were enrolled in the review for final evaluation. The Kirkpatrick Model was employed to analyze and synthesize the included studies.

CONCLUSION: Reviewing the conducted studies showed that medical students had positive responses and attitudes toward new teaching methods, self-monitoring skills, and attention to physiological needs. The results also indicated that new teaching strategies, attention to self-monitoring skills, and sleep hygiene in medical education could positively affect learning in two domains of Bloom's Taxonomy.

Keywords:

Educational intervention, medical student, new teaching strategies

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Introduction

Responsive education and accountability are considered as the main duties of the universities. Every year, universities admit new students and graduate some others, so medical schools have the difficult duty of supporting students for their career. Besides, this career needs continuous adaptation for changing knowledge and skill. In addition, students must have other competencies such as being excellent communicators, leaders, managers, and team workers.[1-4]

Studying in a medical school requires many cognitive abilities, a positive attitude, and an ability to manage the time and respond to challenges during the training, which is called self-management. Medical students can manage themselves when encountered with various kinds of stresses, especially when they finish the premedical year and then continue their preclinical years in different environments. The premedical study is different from the preclinical study in several aspects including a lot of learning materials and an increased workload required to accomplish the courses.[5,6]

The transition from premedical to higher education and preclinical is often

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experienced as challenging and difficult by the students. The main concern is to help 1st-year students become familiar with what it means to be a self-managed and independent learner. Time management is particularly difficult for students to learn. First-year students have poor classroom participation and need to adopt a new style of learning.[7] Another important issue is the new "Millennial Student." Students are required to have skills to manage their daily life. They are determined and those who are dependent on technology and their support system.[8] Therefore, teaching 1st-year students has more challenges than that of senior students. There is consequently a need to develop academic literacy, not only as an adjunct "skill" but also through engagement in learning in the process of academic disciplines. Fisher (1995) discuss that students need to acquire not only the explicit knowledge (as in the content of the curriculum) but also the tacit knowledge (e.g., learning to understand and interpret the values, beliefs, or social practices of a particular community of scholars).[9] The preclinical study is integral for clinical year training because medical students are supposed to apply and implement their knowledge during clinical practice. Therefore, we aimed to identify the intervention and learning behavior of medical students during the first preclinical year for these students faced more academic difficulties and began to develop poor grades during the 1st year of preclinical training. The increase in poor academic performance was more apparent in their clinical years. Therefore by identifying interventions to improve academic performance, we can decrease poor academic performance in clinical years.[5]

There is a good deal of evidence indicating that improving preclinical academic performance can decrease dropout rates and improve academic success until graduation. Accordingly, there is a pressing need to integrate evidence and evaluation of the outcome regarding preclinical academic interventions to guide medical teachers to choose the best educational intervention to improve academic performance in preclinical phase in the future.

To the best of the researchers' knowledge, this is the first systematic review in this research area. The present review study attempted to focus on the preclinical intervention to improve the academic performance of the students in medical programs. The necessity of this work lies in the fact that this intervention is a relatively a deep and systematic examination of the results of educational intervention in medical education can improve the medical teachers' insights into the subject under consideration. Consequently, the present study was carried out to synthesize the findings based on the experimental works and to offer a deeper insight into the outcome of educational intervention in preclinical academic performance.

Materials and Methods

This systematic review was conducted on all the educational interventional studies in preclinical medical courses from January 1987 to January 2018. The methods of presenting including determination of the study problem, data collection, analysis, and interpretation of the findings were performed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting system. To achieve the intended studies, published articles in databases such as PubMed, Web of Knowledge (Thomson Reuters), Educational Resources and Information Center, and the Scopus were searched. No time limitation was set for searching the resources. For comprehensiveness of the search, the following keywords were used in the abstract, title, and keyword sections: "academic performance," "academic failure," "academic achievement," "drop out," "academic engagement," "learning disorder," "medical student," "struggle student," and "problem learner." Hand searching was also carried out in Medical Teacher and Medical Education journals. Besides, reference lists of all the papers meeting the quality criteria were reviewed identifying and selecting the relevant papers. The most prominent authors in this area were contacted with a request for "gray literature:" conference proceedings, unpublished studies, internal reports, etc., and the obtained data were included in the study. The inclusion criteria for the articles were as follows: being an educational interventional study and assessing the academic performance of the undergraduate medical students without any language or time limitation from January 1987 to January 2018. Besides, the exclusion criteria for the search were being secondary research or observational study design and not being a preclinical medical student. All the databases were searched by one reviewer, and Endnote X8 was used for data management. The articles were imported into Endnote X8 to remove the duplicate data before importing the data into Excel. The imported data were the list of authors, titles, journals, and years of publishing. The titles and abstracts were screened by two independent researchers to determine the potentially relevant articles. The full-text version of the study was subsequently reviewed if the study appeared to meet the selection criteria or if there was any doubt regarding the study's eligibility. Moreover, a third independent researcher was requested to resolve any disagreements.

To increase the validity and reliability of the study, the articles were examined in terms of quality by two separate researchers. Each article entering the study was examined in terms of methodological quality using

the tools the validity of which had been supported by the best evidence medical education (BEME) review on education portfolio. The tool was part of the data extraction sheet and included 11 quality indicators about the appropriateness of the study design, results, analysis, and conclusions, which were used to examine the quality of the studies. The tool has been recommended for quantitative, qualitative, and combined-method research in medical education.[10] The studies that met a minimum of eight quality indicators or those meeting six or seven criteria were categorized as high-quality and medium-quality, respectively. Furthermore, those studies that met five or fewer criteria were considered as low-quality studies.[11] For adequately homogeneous data, for example, studies with similar interventions, comparisons, outcomes, and study design-standard methods for meta-analysis (Cochrane Handbook) were employed. Nonetheless, according to other systematic reviews in the medical education literature, it is assumed that the collected data may be extra heterogeneous, which makes it improper to be mixed for quantitative statistical meta-analysis. If so, a qualitative review of the evidence would be carried out through grouping and reporting studies using the Kirkpatrick hierarchy introduced by BEME for educational contexts.[12] The search identified 6305 abstracts. Totally, 480 articles were selected for further review. The final review included 10 articles. The majority of them ($n = 9$) were identified from electronic databases and the balance[1] was identified from the reference lists. Articles were most likely to have been published in medical education and medical teacher journals [Figure 1].

Results

Based on a systematic review of the educational papers published during 1987–2018 on preclinical interventions in medical education, 10 interventional studies were extracted and used to form the basis for answering the research questions. Two approaches were employed to conduct the present research review. Half of the articles were investigated using an experimental approach through randomization technique.[13-17] The other half were reviewed applying a quasi-experimental design. Meanwhile, in these articles, the subjects had not been randomly assigned to the test and control groups.[18-22]

Countries under investigation – Based on the results, India was at the top of the country list in terms of the number of studies ($n = 3$) followed by Turkey ($n = 2$). The United States of America, Canada, UK, Germany, and Croatia were found to have only one article.

About population – In terms of professional groups in the 10 cited articles, the educational intervention was used by the preclinical medical students (first-, second-, and third-year students).

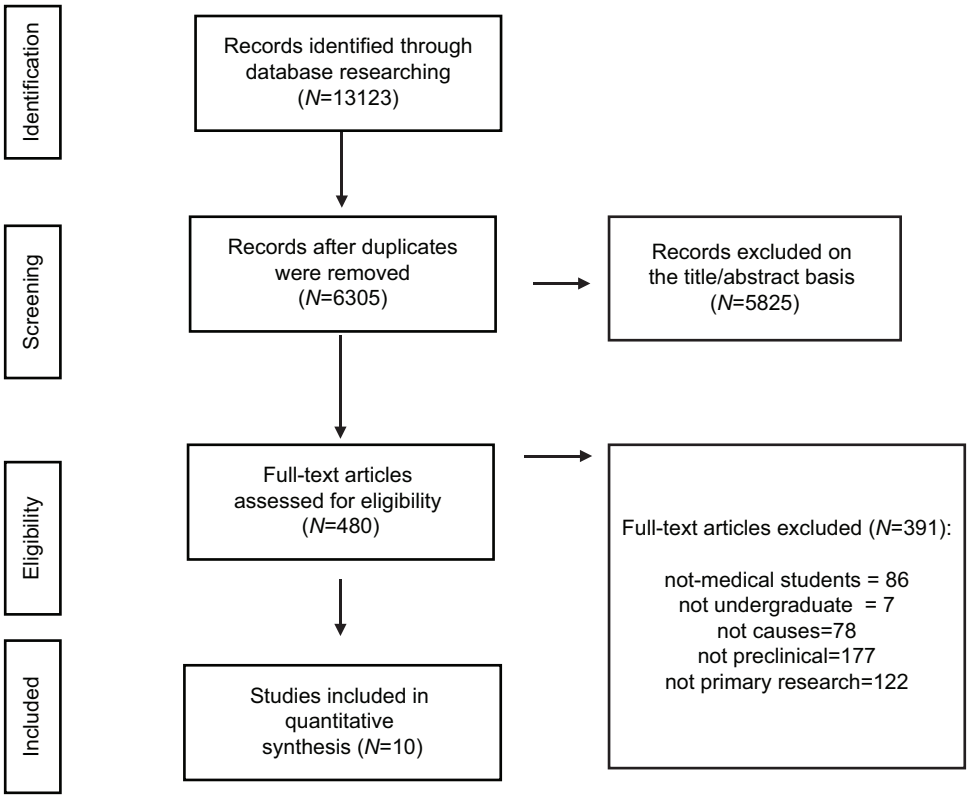

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart

For methodological quality – There were five high-quality[13-17] and five medium-quality[18-22] papers. Besides, no low-quality paper was included in the present study. All the papers were compared based on the 11 quality indicators, namely, control of confounding, triangulation, ethical issues, and analysis of the results, conclusions, data collection methods, prospective, reproducibility, completeness of data, research question(s), and study participants. The most commonly met indicators were appropriateness of perspective, analysis of the results, and conclusions of data. Nevertheless, on many occasions, the data collection method (if the data gathering method was reliable and valid for the research question and context) was not clear due to insufficient data. Clearly, because of the quantitative nature of the papers in this work, a low triangulation was expected [Table 1].

Based on the Kirkpatrick outcome levels – The proportion of papers that evaluated the effect of the educational intervention at each Kirkpatrick outcome level is listed in Table 2.

Changes in knowledge/skills (levels 2B) were reported in all the papers and only two papers mentioned the evaluation of the students' learning transfer into their workplace (level 3).[18] Moreover, five articles reported two or more outcome levels.[13,17,18,20,22] There was no report regarding the effects on the system/organization or patient care outcome as a direct outcome of the knowledge, skills, and attitudes developed by the subjects in the educational intervention (level 4).

Synthesis of findings

The outcomes of educational intervention are synthesized in the following sections based on three categories, namely, (I) improvement in students' skill; (II) acquisition and enhancement of the students' theoretical knowledge; and (III) positive attitudes and perceptions of the students.

Students' skill improvement

There was no article about the impact of educational intervention on students' skill learning.

Acquisition and enhancement of student's theoretical knowledge

In all of the studies carried out regarding the effects of educational intervention on medical students' performance, a positive impact was found on their theoretical knowledge. The summary of interventions can be stated as follows: the effect of (I) self-monitoring exercises on biomedical sciences;[13] (II) concept mapping on learning biochemistry;[14] (III) blending problem based learning (PBL) with web technology on learning physiology;[15] (IV) counseling and advising regarding study skills;[18] (V) teaching on learning outcomes by peer educators;[16] (VI) self-directed learning on learning effect;[17,21] (VII) sleep hygiene education on academic performance;[19] (VIII) student-led objective tutorial (SLOT) on academic performance;[20] and (IX) PBL program enrich with brain/mind learning (BML principle).[22]

Students' positive attitudes and perceptions toward educational interventions

There were five studies regarding the effects of educational interventions on attitudes and perceptions about academic achievement in the subjects. Leggett *et al*. showed a significantly increased self-efficacy and greater satisfaction with performance respecting self-monitoring exercises.[13] Besides, Mysorekar demonstrated a significant increase in satisfaction scores compared with those of the baseline and after the counseling and advice regarding the study skills.[18] Peine *et al*. also indicated that the intervention group had a notable increase in learning motivation compared with the control group.[17] Sukhlecha reported that the students in SLOT groups found the support by the peer educator significantly more positive than that evaluated

Table 1: Quality of included studies

Quality indicator	Details	Indicator met	Indicator not met
Research question	Is the research question or hypothesis clearly stated?	8	2
Study subjects	Is the subject group appropriate for the study being carried out (in terms of the number, characteristics, selection, and homogeneity)?	5	5
Data collection methods	Are the methods used (qualitative or quantitative) reliable and valid for the research question and context?	3	7
Completeness of data	Have the subjects dropped out? Is the attrition rate of less than 50%? Is the response rate acceptable (60% or above) for questionnaire-based studies?	3	7
Control of confounding	Have multiple factors/variables been removed or accounted for, where possible?	4	5
Analysis of the results	Are the statistical or other methods of results analysis used appropriately?	7	3
Conclusions	Is it clear that the data justify the obtained conclusions?	8	2
Reproducibility	Could the study be repeated by other researchers?	4	6
Prospective	Does the study look forwards in time (prospective) rather than backward (retrospective)?	9	1
Ethical issues	Were all the relevant ethical issues addressed?	4	6
Triangulation	Were the results supported by the data from more than one source?	1	10

by those in the control group.[20] In addition, according to the report by Gulpinar *et al*., all the subjects stated that the PBL program enriched with BML principles was the best study method.[22] A summary of the main findings of several studies is provided in Table 3.

Discussion

This systematic review aimed at searching, analyzing, and synthesizing experimental articles conducted on educational intervention in medical sciences education during 1987–2018. To the best of the authors' knowledge, this study was the first work of this nature. In general, the application of educational interventions for preclinical medical students was few and only 10 articles were found during the period of searching in this regard. Therefore, there was a need for an original article regarding the area under investigation. The rigor of studies on evaluation of educational outcomes has been relatively weak, mostly regarding the limited tools utilized to measure the learning results. The major part of the reports on changes in attitude has mainly relied on self-statements by the students.[23]

In addition, the period of the interventions varied form 1 day to even months in the published studies. Accordingly, a significant issue to be carefully investigated in future research is the frequency of intervention delivery as continuous or repeated interventions and their effects on educational outcomes. Only in one study which was carried out by Mysorekar, there were subsequent assessments after 1 and 6 months, respectively.[18] However, in other articles mentioned in this review, there was not any subsequent evaluation. In many studies, the interval between pretest and posttest was very short. This may have led to bias, meaning that better methodologies and longer time duration are required for the researches on educational intervention in future studies to determine its educational effects on the students' performance.

None of the articles under study mentioned any changes in organizational practice or improvement in patients' health results as a direct effect of the educational intervention (Kirkpatrick's 4 levels) and a change in behavior (Kirkpatrick's 3 levels). However, this is an ordinary practice in medical education reviews. Knowing this, such a level of evaluation needs a long-term follow-up. Moreover, it is not feasible to take into account the complexity of the factors affecting the practice of patient care. Although this study was about preclinical performance, the author can examine the effect of such intervention through following up the participants.

Table 2: Distribution of reviewed studies based on Kirkpatrick outcome levels

Levels	Kirkpatrick outcome level	Studies (*n*)
1	Reaction-learners' reactions	5
2A	Learning -change in view or attitude	1
2B	Learning-modification of knowledge or skill	10
3	Behavior-change in behavior (transfer of learning to the workplace)	1
4A	Results-change in the system/ organizational practice	0
4B	Results-in patent care outcome	0

Table 3: Summary of the reviewed studies

ID	Authors	Countries	Aims of the study	Participants	Design	Main findings
1	Leggett (2010)	UK	Improve their academic performance by self-monitoring exercises	51 2nd-year students	Randomized trial	Improved their BMS exam score compared with the control group
2	Surapaneni (2013)	USA (Chicago)	Effect of concept- mapping on learning biochemistry	150 1st-year students	Experimental	Concept-mapping program resulted in higher academic performance
3	Taradi (2005)	Croatia	Effect of blending PBLwith web technology on learning physiology	121 2nd-year students	Experimental	Blending PBL with web technology positively impacted on student learning
4	Mysorekar (2012)	India	Effectiveness of counseling and advice regarding study skills in improving performance	73 1st-year students	Quasi-experimental	Improvement in the postprogram performance
5	Peets (2009)	Canada	Effects of teaching on learning outcomes of peer educators	135 1st-year students	Randomized cross-over	Involvement in teaching small group sessions improved medical students' knowledge acquisition and retention
6	Peine (2016)	Germany	Self-directed learning on learning effect and student satisfaction.	244 3rd-year students	Randomized trial	Self-directed learning improved learning and satisfaction
7	Sahin (2016)	Turkey	Effects of sleep hygiene education on academic performance	131 1st-year students	Quasi-experimental	Education on sleep hygiene improved academic performance
8	Sukhlecha (2016)	India	Effect of SLOT on academic performance	171 2nd- year students	Quasi-experimental	SLOT improved academic performance
9	Vashe (2013)	India	Self-directed learning on academic performance	230 1st-year students	Quasi-experimental	Self-directed learning improved academic performance
10	Gulpinar (2015)	Turkey	Effect on PBL program enriched with BML principles on academic performance	295 1st-year students	Quasi-experimental	PBL program enriched with BML principles improved academic success

PBL=Problem-based learning, BML=Brain/mind learning, SLOT=Student-led objective tutorial, BMS=Burning mouth syndrome

The results of the present review indicated that educational intervention with three different types such as attention to teaching method (e.g., embedded e-learning, different type of PBL, and self-directed learning), attention to physiological needs (sleep hygiene), and self-monitoring skills (e.g., self-regulation exercise and teaching study skill) can be used to improve the academic performance in light of both domains of Bloom's taxonomy such as cognitive and affective for the students in medical programs. In fact, Bloom's taxonomy is an easy way employed to describe the required degree of understanding and using concepts and to influence their values, attitudes, and interests.[24] Studies which is consistent with the finding of the present study about active teaching method is a study by Moust *et al*., that compared students who had participated in PBL with study teams with students who had used the traditional self-study showed that working with teams fostered deeper learning as well as increased students' workloads;[25] although, there is challenges that researchers and instructors faced recently is working with active teaching method such as small groups, including problems experienced during group tutorial processes such as insufficient use of scenarios; improper management of tutorial processes; difficulties in some of the steps of the seven-step approach. Managing group dynamics, and deepening discussions. Hence to handle this challenge, we need workshop for faculty development. Another one, it seems using self-monitoring skill have no challenge. Hence, self-monitoring, can be developed by appropriate interventions and also that academic performance can be improved. Moreover the next one, sleep quality is important for academic performance among medical students, it has been suggested that by awareness of the possible impact of excessive daytime sleepiness on the medical students will help to the teaching staffs to manage sleep education and sleep hygiene, especially to those who were identified as potential individuals.

The results of this review study contribute to the achievement of a better planning and designing of an efficient education in respect of the method of teaching, attention to physiological needs, and self-monitoring skills in medical education. All these findings could assist medical teachers in a medical curriculum understand the activities and lifestyles of medical students and help them guide ways to improve students' academic achievements. In addition, there is also a need to consider changes in teaching objectives that foster cooperative learning and actively participate in the professional development of medical students as an essential aspect of their role as medical science educators.

Conclusion

The current systematic review was an attempt to give a general picture respecting the extent of intervention suggested in the literature and provide medical teachers with the best and most recent evidence to select the best intervention(s) in medical curriculums. Using the findings, the students will also better enjoy the advantages of interventions in their academic, clinical, and professional endeavors. Besides, they will be prepared for future licensing requirements. The main points that medical education policymakers and practitioners need to take into account in the design of a proper program are attention to new teaching strategies, attention to self-monitoring skills, and sleep hygiene. Moreover, the obtained results can be used as a basis for further studies and development of knowledge in this field. Future studies on different student groups of medical sciences and countries require focusing on standardized and validated evaluation tools in randomized controlled trial settings. With regard to the limitations of the study, lack of a meta-analysis was notable. However, it was not possible to do a meta-analysis because of the wide range of different study designs, measurement tools, results, and the nature of the results reported. Nonetheless, the current review had a strong point in terms of not having any language limitation.

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Conflicts of interest

There are no conflicts of interest.

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