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Review Article

Determining the effectiveness of peer-assisted learning in medical education: A systematic review and meta-analysis

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الملخص

أهداف البحث: على الرغم من شعبيتها، لم تُظهر الأدبيات ما يكفي من الأدلة التي يمكن أن تثبت صحة تأثير التعلم بمساعدة الأقران على التعلم الفعال للطلاب. يهدف هذا التحليل البعدي إلى التحليل الكمي لفاعلية التعلم بمساعدة الأقران في التعليم الطبي.

طرق البحث: تم البحث في قواعد البيانات المختارة باستخدام مصطلحات الشبكة" مساعدة الأقران"، و"التعلم" أو "التعلم الفعال" أو "استراتيجيات التعلم" أو " توجيه الأقران" أو "تعليمات الأقران" لإيجاد دراسات تشمل النص الكامل باللغة الإنجليزية مع معلومات قبل وبعد الدراسة. بعد بروتوكول منهجي، اخترنا ١١ مقالا للتحليل النهائي. وتم إجراء التحليل البعدي باستخدام برنامج المراجعة الإدارية ٥.٣ من مكتبة كوكرين، وتم عرض المخرجات النهائية على شكل مخطط غابي.

النتائج: أظهرت النتائج فاعلية كبيرة للتعلم بمساعدة الأقران؛ فرق المتوسط المعياري ١.٢٦ مع فاصل ثقة ٠.٥٨ إلى ١.٩٤. أظهر اختبار كوكرين Q مستوى الأهمية ٥٪ كما تم قياسه بواسطة مربع كاي ٤٤٩.٤٦. إلى جانب ذلك، كانت نتائج اختبار I[2] مهمة (٩٨٪). تتحقق قيمة Z بمقدار ٣.٦٥ من فاعلية التعلم بمساعدة الأقران.

الاستنتاجات: أظهر هذا البحث أنه يمكن استخدام التعلم بمساعدة الأقران كأداة تعليمية قيمة في المجال الطبي. يمكن للتدخلات التعليمية في المناهج الدراسية وإدراجها في استراتيجيات التعلم بواسطة الأقران أن تعزز خبرة التعلم لطلاب الطب.

الكلمات المفتاحية: التعلم بواسطة الأقران؛ مراجعة منهجية؛ التحليل البعدي؛ التعليم الطبي؛ التعليم الفاعل

Abstract

Objective: Despite the popularity of peer-assisted learning (PAL), existing literature has not shown enough evidence that can validate its impact on students' active learning. This meta-analysis aims to quantitatively analyse the effectiveness of PAL in medical education.

Methods: We searched selected databases using the Medical Subject Headings (MeSH) terms 'peer-assisted', 'learning', 'active learning', 'teaching strategy', 'peer mentoring', and 'peer instructions' for full-text English language studies with a pre-post design. Following a systematic protocol, we selected 11 articles for final analysis. A meta-analysis was done using Review Manager (RevMan) 5.3 from Cochrane Training and the final output was presented by a forest plot.

Results: The results showed a significant effectiveness of PAL; notably, there was a standardised mean difference of 1.26 with a confidence interval of 0.58—1.94. The Cochran's Q test showed a 5% level of significance as measured by $Chi^2 = 449.46$. Besides, the results of the I^2 test were significant (98%); moreover, a z value of 3.65 validated the effectiveness of PAL.

Conclusion: This research has shown that PAL can be used as a valuable learning tool in the medical field. Educational interventions in curricula for incorporating PAL strategies can potentially enhance the learning experience of the medical students.

Keywords: Active learning; Medical education; Meta-analysis; Peer-assisted learning; Systematic review

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Introduction

Peer-assisted learning (PAL) is a type of learning where students from the same programme — not necessarily from the same level in the programme — help each other to learn. Generally, it refers to people from the same social class who are not acting as professional teachers but still help each other to learn.[1] PAL embraces a wide variety of activities undertaken by students, including discussion seminars, counselling, and collaborative work projects — all of which occur in a framework of different-sized groups, workplace-based coaching, and a range of community services.[2] This unique learning strategy is an abstract term encompassing bilateral, reciprocal learning experiences that are mutually beneficial to all participants by promoting the active engagement of learners.[3]

Educators have proposed several variants of PAL that have been described in different taxonomies and definitions. The Association of Medical Education in Europe (AMEE) guide about PAL has identified it as a planning and implementation framework with approximately 18 different types of learning strategies that can be led by peers such as peer appraisal, peer-assisted study, peer tutoring, peer teaching, etc.[4] Other researchers have elaborated on other elements of PAL such as peer learning (when the students belong to a same class) and near-peer learning (when the tutors are seniors to their students). Nevertheless, all variants of PAL carry a similar description of collaborative learning among the students.[5] Collaborative learning is an interchangeable term that includes a set of structured and focused activities for the students who work in groups to solve, thus motivating interdependent learning.[6] However, in both of the learning activities, learning rather than educating is the key desired outcome.

Current literature has shown that the learning process in PAL encompasses constructivist social theories where peers feel comfortable enough to interact and communicate with other colleagues more so than with faculty.[7] Other learning theories such as the cognitive learning theory can also be implemented to explain the learning process in PAL. This is where similarity in knowledge levels between peers will provide better understanding of the learners' knowledge needs.[8]

The pragmatic reasons for advocating PAL spring from the fact that this learning pedagogy encourages critical thinking, clinical reasoning, problem-solving, professional development, and knowledge acquisition by exploration, argument, training, and mentoring among peers.[9,10] In addition, other advantages of PAL can include — but are not limited to — high acceptance by the students and enhanced students' motivation towards learning as they find the learning environment more comfortable than one that is driven by the teacher—student interaction.[11] On the other hand, it is reported that PAL can also help in preparing future educators and reduce some of the efforts by class teachers.[12] Some reports have referred to PAL as one of the learning strategies for cost-effective education.[13,14]

Worldwide, there is a growing interest in PAL in the medical sphere that resonates with increasing medical student intake, limited teaching resources, and a persistent drive towards economy and cost-effectiveness. PAL enriches not only self-directed and cooperative learning, but also a large number of students can actively learn in a group environment.[15] Burgess et al. (2014) have proposed the multidimensional advantages of PAL for all of the stakeholders in a medical education.[16] At the institutional level, PAL can potentially reduce the faculty teaching load and may help the students to inculcate a life-long learning experience by acquiring skills through reflections and providing feedback.[17] The existing literature has argued that PAL is associated with cognitive, pedagogical, behavioural, and social gains.[4] In fact, PAL helps the students to acquire organisational, interpersonal, and teaching skills; moreover, PAL can bridge certain gaps in the curriculum as identified by the students.

With the given background, it is customary to understand that PAL should not be considered as a substitute to teaching activities delivered by faculty but as an attractive and valuable supplement to the teaching and learning activities that can enrich the educational environment.[7] A great proportion of PAL informally occurs in the absence of faculty, and the students happen to learn disproportionately when it is left to chance.[18] Conversely, formalised and structured PAL can help facilitate the students to independently learn. Thus, a carefully designed PAL framework has the potential to facilitate student-oriented learning, particularly in interprofessional education and practice.[19,20] Literature has provided anecdotal evidence that simulation[21] as well as professional training of educators[22] for facilitating group learning can enhance effectiveness of PAL[23]. An interesting utilization of PAL can be collaborative educational research[24], which can foster critical thinking and creativity during group assignment.

Despite a wealth of proposed benefits of PAL and the endorsement of its educational effectiveness by the General Medical Council,[25] uncertainty prevails about the effectiveness of PAL as its impact on students' learning and assessment has not been qualitatively investigated.[26] In addition, the literature has presented contradictory and conflicting reports on outcomes of PAL intervention in the curriculum; notably, others have recommended PAL,[27] while some evidence has argued about the ineffectiveness of PAL for students' learning.[3] The goal of this systematic review and meta-analysis is to quantitatively measure the effectiveness of PAL in improving students' learning.

Materials and Methods

Search design

During January 2018, the databases of MEDLINE, ScienceDirect, Ovid, EBSCO, and Web of Science were searched using the Medical Subject Headings (MeSH) terms 'peer-assisted', 'learning', 'active learning', 'teaching strategy', 'peer mentoring', 'peer instructions'. Accordingly, full-text English language studies published from 2005 to 2017 with pre-post designs were searched in the selected databases that quantitatively compared the impact of PAL in

undergraduate and postgraduate medical and health science disciplines. Pre-post designs provide more robust comparison as research is conducted on the same group − thus, the internal consistency of the results is substantially improved. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were employed during this search.[28,29]

Inclusion and exclusion criteria

The inclusion criteria for selecting articles included 1) pre-post research design articles that explored the effectiveness of PAL in medical education and 2) empirical and original studies that published data with average and standard deviations. Review and editorial articles, commentaries, personal opinions, and conference proceedings were excluded from this search.

Data extraction

An initial search through selected databases yielded 2381 articles. Yet, during the analysis of abstracts of these studies, 522 articles were excluded due to duplications and publications as shown in Figure 1. A further analysis excluded 1,791 studies due to the irrelevance of research work. Finally, 68 studies were found to be relevant; however, with regard to the full-text analysis of these studies, the researchers removed another 57 articles due to inappropriate data. Thus, a list of 11 articles was selected for this systematic review and meta-analysis.

Quality assurance and addressing selection bias

Both authors performed independent literature reviews and selected and analysed studies. Regarding any differences in opinion and controversies, they reached a consensus by referring to the selection criteria and MeSH terms. The variations in findings as identified by the researchers were discussed until a scientific agreement was achieved and all concerns were resolved.

In this study, the meta-analysis was done by utilising Review Manager (RevMan) 5.3 software developed by Cochrane Training.[30] The graphical representation of the effect size generated by this application was represented by a forest plot. This approach quantitatively analysed the consistency and reliability of results from the selected studies. In this plot, the effect size of each study is computed as an outcome, and pooled effect sizes are also calculated in order to observe heterogeneity among the studies. A Q test was applied for the analysis of heterogeneity in the selected studies. The null hypothesis in this research assumed that 'all studies are identical'. Finally, the I^2 statistic was applied to ensure the quantity of heterogeneity in percentage terms for the validation of consistency of the selected studies.[31] After a careful analysis of heterogeneity, the appropriate selection of a summary model of either fixed effects or random effects was undertaken. In the case of low heterogeneity, a fixed effects model is recommended; conversely, in the event of high heterogeneity, a random effects model is suggested.[32] The Tau-squared (Tau^2) estimates the difference between study variance in the random effects model. Finally, the level of significance in this study is 5% ($p < 0.05$).

Results

Using the defined selection criteria, the algorithm for selection of studies is outlined in Figure 1.

A further analysis of the selected studies with their salient features is shown in Table 1.
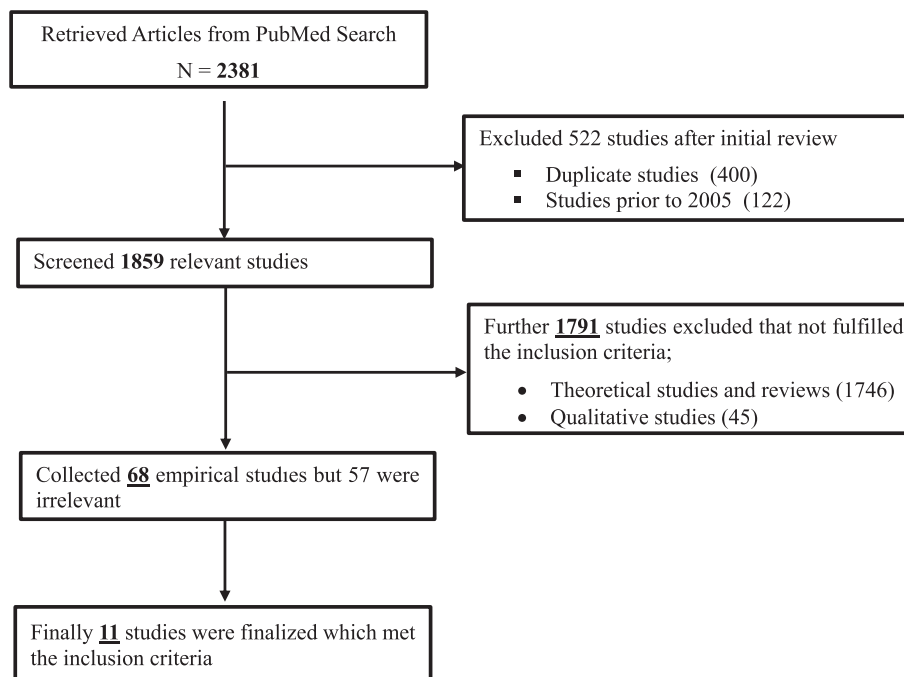
Figure 1: Algorithm of step-wise selection of studies about peer-assisted learning in this meta-analysis and meta analysis.

Table 1: Key features of the selected studies that measured the effectiveness of peer-assisted learning in this systematic review and meta-analysis.

No.	Citation	Country	Study design	Discipline	Key findings
1	Nomura O, et al. (2017)[45]	Japan	Mixed methods study: a randomized controlled non-inferiority trial and focus groups discussion	Medicine	- This study identified 13 concepts from focus group discussions embracing three major themes; benefits of CYPT, reflections of participants and contrast with faculty. - A mean difference of 0.2 with a 95% CI of -1.8 to 2.2 was deduced from this study
2	Shah I, et.al (2017)[15]	Pakistan	Randomized controlled study (Solomon four-group design)	Medicine	- A pre-post design was applied to assess performance in the physical examination - PAL group marks were significantly greater than the experts led the group. (p-value $= 0.00$)
3	Han ER, et al. (2015)[2]	South Korea	Experimental (PAL) group and control group (Faculty-led)	Medicine	Self-assessment scores in the PAL group are considerably greater than the faculty-led group in all items (p values 0.00 -0.022) except one item (p-value 0.274)
4	Manzoor I. (2014)[46]	Pakistan	Cross over-randomized control trial followed by a cross-sectional survey	Medicine	- Differences in score between groups who used the two methods (PAL and experts led) were not significant statistically. - A total of 46.3% of students agreed that PAL is an effective method, while 70.4% indicated easiness to communicate with a peer. - Overall, 44.4% of students preferred to include PAL in the curriculum.
5	Sevenhuysen S, et al. (2014)[47]	Australia	Prospective, assessor-blinded, randomized crossover trial	Physiotherapy	- The PAL model showed some benefits to faculty workload and student feedback - However, no significant difference was found among the studied groups; blinded assessor ($p = 0.43$), the supervising clinical educator ($p = 0.94$) or the students ($p = 0.99$).
6	Kühl M, et al. (2012)[26]	Germany	Randomized control trial with pre and posttest design	Medicine	- The two groups (expertly led and peers led) showed improvement in the post-test and the peer-led group showed more improvements. - The difference in improvement for both groups is statistically significant ($p = 0.03$).
7	Carr WD, et al. (2011)[48]	USA	Randomised, pretest, posttest experimental design	Athletic Education	The posttest scores were meaningfully different for the peer-assisted learning group ($p = 0.004$)
8	Yu et al. (2011)[49]	Germany	Randomised, pretest, posttest experimental design	Medicine	- Both groups (students-led and faculty-led showed improvement in posttest, ($p < .0001$ each). - Regarding improvement of the students-led versus the faculty-led presented no change between two groups ($p < .05$ testing for equivalence.
9	Knobe M, et al. (2010)[50]	Germany	A randomised controlled for assessment of post-intervention impact using PAL as student-teachers	Medicine	- Students-teachers model showed significantly better results overall ($p < 0.05$). - Complex technical skills can be adequately delivered to the students using the PAL system by students-teachers model
10	Weyrich P, et al. (2009)[27]	Germany	A prospective randomised controlled trial on medical	Medicine	- PAL is an effective learning tool for technical procedures in the skills laboratory

Table 1 (*continued*)

| No.	Citation	Country	Study design	Discipline	Key findings
			students that taught technical skills by either cross-year peer tutors or experienced faculty staff.		- PAL can be applied as a useful learning adjunct if implemented by cross-year peer tutors
11	Hudson JN and Tonkin AL. (2008)[51]	Australia	A randomised controlled trial using randon assignment of year two medical students to either year six students or paid doctors	Medicine	- PAL and tutor's groups did equally in the clinical skills examination (difference in the mean total score: 0.7; 95% confidence interval) 3.8 to 2.4). - PAL environment was perceived as a way of confidence development and active learning environment.
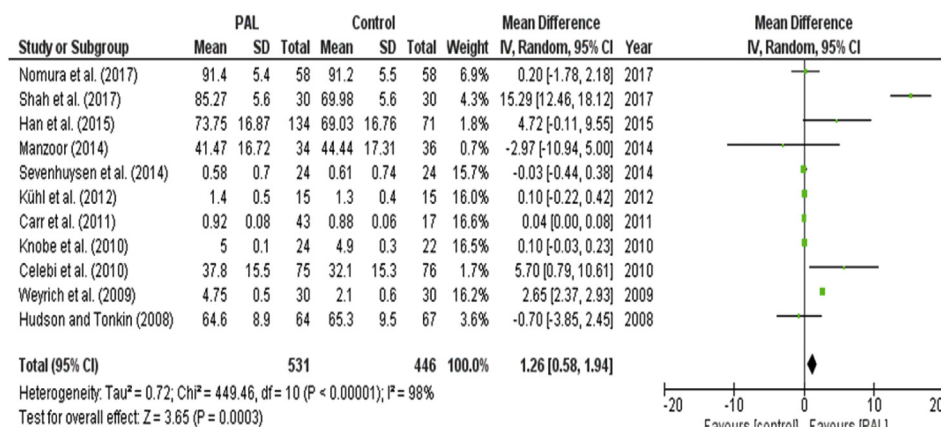
Figure 2: Findings of analysis by forest plot for the effectiveness of peer-assisted learning in this meta-analysis.

The quality of each study was rated on a 5-point Likert scale with 1 being low and 5 being very high. The range of ratings in the selected studies showed 2 (two studies) and 4.7 (nine studies), while the mean quality of selected studies was 3.5. The strengths of the studies were considered by larger sample sizes, pre-post designs, educationally strong interventions, and appropriate data analysis. The study's weaknesses included small and irrelevant sampling, low response rate, and inadequate data analysis.

The forest plot shown in Figure 2 lays down a series of estimates with confidence intervals at a 95% level. Each study's effect size (outcome) is shown by a square-per-box, and their confidence intervals are represented through horizontal lines. The forest plot demonstrated a wider confidence interval with inconsistent response rates and heterogeneity among studies. To analyse heterogeneity statistically, the Q test, I^2, and the Tau^2 statistic were applied, which indicate heterogeneity among study results. Consequently, the Cochran's Q test $(Chi^2 = 449.46)$ is significant at a 5% level of significance and the I^2 is 98%, and as a considerable heterogeneity, a random effects model was a most appropriate model for this research. The effect summary was represented by a diamond which has a standardised mean difference value of 1.26 with a confidence interval of 0.58−1.94. This validates the significant effectiveness of PAL as compared to a control group with a z value of 3.65

$(p < 0.05)$. Statistically, the z-score determines the degree of disagreement or agreement with standard deviations with reference to the mean. A z-score of +2 or above shows that the standard deviation is above the mean. Thus, in this meta-analysis, the given z-score of 3.65 indicates that standard deviations are above the mean.

Discussion

This research provides substantial evidence that peer learning is a significantly effective tool for active learning in medical education. The effect summary represented by a standardised mean difference value of 1.26 with a confidence interval of 0.58−1.94 validates the significant effectiveness of PAL for active learning; notably, there is a z value of 3.65 $(p < 0.05)$. In addition, a mean strength score of 3.5 of the selected studies signifies the high quality of selected studies in terms of sample size, response rates, and appropriateness of the statistical analysis of the data. PAL engages a group of students taking joint responsibility for identifying their own learning needs and managing an individualised educational plan in achieving their learning objectives. Such a learning strategy nurtures the students in working with others, allows for critical inquiry and reflection, enables the discovery of knowledge and skills, and provides for self and peer assessment.[33] The results of this systematic review are supported by

other studies from different health professionals. Awasthi and Yadav, using a small group discussion model of a tutor and four to six peer learners, have reported an improvement in student's performance and test scores after using PAL in a paediatrics course.[34] The researchers conducted a pretest-posttest design and subsequently reported a 24% improvement in the posttest and a correlation of 0.48 ($p < 0.0001$) coefficient between the pretest and posttest scores. The improvement in the students' academic performance was also reported from a study conducted in the United Kingdom (UK), where PAL was used to conduct clinically-oriented tutorials in the pre-clinical module.[35] The results of all five post tutorial quizzes which were used in the study showed a significant improvement in mean student score ($p < 0.05$). Furthermore, both these studies reported an overall satisfaction from the students regarding PAL.

In the study by Seifert et al., the investigators conducted a prospective, randomised, and controlled study on the students at the student-run free clinic of Goethe-University Germany.[36] The students' performance was reviewed before or after receiving PAL. The students in the PAL group performed significantly better in the theoretical ($p < 0.001$) and practical ($p < 0.001$) parts of the tests, while they showed similar results in the Objective Structured Clinical Examination (OSCE) for dentistry ($p < 0.01$). This study reflects some benefits of PAL in improving cognitive and meta-cognitive skills of the students; however, PAL failed to enhance the clinical skills of the study cohort. Buqai et al. have argued that teaching psychomotor skills in labs and training centres can be more effectively achieved by student tutors than by senior teachers.[37] In this study, the authors have alluded that the most powerful motivation for student tutors remained the enthusiasm and aspirations to enhance their own knowledge and skills. In addition, having knowledge of the trainees' specific learning needs helps the teachers in tailoring educational strategies for better learning experiences.[9]

Our research included studies on different medical specialties such as ultrasound, anatomy, and echocardiography as well as communication skills. A wealth of publications have investigated the effectiveness of PAL in several other medical disciplines. From a different perspective, Bennett et al. studied the impact of PAL during three surgical courses run by junior doctors.[38] The study showed significant improvement in posttest evaluations with a range of mean improvement between $+3.42$ and $+6.42$. PAL has been shown to be far more instrumental in enhancing the learning experience because it is relatively easy to organise and does not require keeping a formal timetable.[39] Reciprocal peer learning underpins the emphasis on the learning process, including the emotional and intellectual support that learners offer each other. In sharp contrast to peer teaching where the roles of teacher and learner are fixed, PAL features undefined roles of learners that may fluctuate during learning experience.

A study compared the impact of PAL with lecture-based teaching, and the results showed a significant difference in the pre-test and post-test scores in favour of PAL.[40] The lecture-based groups did not show a statistically significant difference in their post-test scores A scoping review has reported six studies that showed no difference in students' academic performance among groups using PAL versus groups using teachers-led educational techniques.[41] Similarly, a study by Cameron et al. did not find a significant difference in the students' performance in the final OSCE for dentistry between the students' who were involved in PAL and those who were taught by teachers in dental skills.[42] Moreover, research on peer learning has elicited benefits other than improvements in academic performance. Williams et al. have reported an increase in self-reported confidence in conducting tutorial session following PAL strategy[43] and another study has shown that the students considered PAL as being a beneficial and enjoyable experience.[44]

From our literature search on the effectiveness of PAL, we identified one study by Williams and Reddy where the students − utilising aseptic techniques in the PAL group − did not perform as well as the students in the other group. The authors have argued that this ineffectiveness of PAL might be attributed to the difficulty and complexity of the task being performed. Such reports provide a strong scientific impetus for conducting more studies on PAL in various disciplines that can help create a unified instructional strategy in medical education. Furthermore, there is limited evidence about the effectiveness of PAL for improving presentation skills, group work or projects, and spatial skills. Though the acquisition of such skills and competence by PAL is more robust and time-consuming, more evidence-based research using interventions may be able to provide further details.

Study limitations

This systematic review and meta-analysis involved analysed studies that investigated the impact of PAL on diverse medical disciplines. The effectiveness of PAL in certain other medical disciplines has not been studied, and this shortcoming can imply validating these research findings. Another limitation was the selection of studies published in the English language. Accordingly, future studies are needed to overcome the research bias of language and should include more disciplines for a wider scale analysis.

Conclusion

In this meta-analysis, a mean quality score of 3.5 of the selected studies provides reliable evidence that PAL can be used as one of the recommended teaching and learning methods in medical education. There is substantial evidence that a well-structured PAL programme can facilitate learning among medical and allied health sciences students. The results of this study indicate that PAL is a powerful teaching and learning strategy that not only enhances students' effective learning, but can also potentially improve their academic performance.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

The Manuscript is a meta-analysis and it does not involve human subjects and hence the need for ethical approval.

Authors contributions

SG conceived the research theme, conducted the systematic review and the meta-analysis and wrote the initial draft. MEA performed the initial literature review and contributed in the final selection of the articles. Both authors significantly contributed to this research and hold responsibility for its quality and content. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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