

Original Article

Utilizing Structured Peer-Assisted Learning In Undergraduate Clinical Research Training: A Quasi-Experimental Study

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Abstract

Objective: To assess the effectiveness of a Peer Assisted Learning (PAL) program, as an adjunct to traditional teaching methods, in enhancing clinical research knowledge and providing practical research experience to undergraduate medical students. The study also aimed to explore students' perceptions of PAL.

Methodology: A 6-month PAL program was introduced at Rawalpindi Medical University, pairing undergraduate mentors from the MBBS program with mentees in 21 research groups. The program focuses on research methodologies and observational studies. We collected research knowledge evaluation (RKE) scores and program perceptions from mentees and mentors, with a control group for comparison.

Results: Participation in the PAL program led to a significant improvement in mentees' research knowledge, reflected in a mean RKE score increase from 11.00 to 13.00 ($p < 0.001$). The control group's scores before and after the program showed no statistically significant change ($p = 0.579$). Post-PAL scores of mentees were significantly better than those of the control group ($p < 0.001$). Mentees and mentors provided positive feedback about the program, with 72/82 (87.8%) of mentees agreeing that PAL was effective and 65/82 (79.3%) preferring it over traditional teaching methods.

Conclusion: Participation in the structured PAL program was associated with improved research knowledge and positive perceptions among undergraduate medical student participants. However, due to the non-randomised design and baseline differences between the groups, causal conclusions cannot be drawn. PAL may serve as a feasible and scalable adjunct to faculty-led research training, particularly in resource-limited settings.

Keywords: Medical Education, Mentoring, Research, Undergraduate.

Introduction

In the developing world, research quality is deemed satisfactory, albeit constrained by many limitations. Research endeavours in Pakistan are still in their nascent stages. Given the expanding scope of biomedical research, the integration of research training has been recognised as imperative within medical education.¹ Additionally, research is vital for developing critical thinking and appraisal in an individual, leading to improved health care.² Incorporation of research training at the undergraduate level varies from making it part of the curriculum to providing voluntary research elective opportunities.³⁻⁵

Once limited to postgraduate scholars, research is now essential to the future of medicine, with evidence supporting its early integration into undergraduate education to enhance competency.^{4,6} While some institutions lack early research exposure for undergraduates, others limit it to research electives or programs, benefiting only a select few students.⁷ In contrast, many medical schools now incorporate research into their curricula to better prepare students for future health challenges.^{3,4} Expanding research capacity at both the institutional and individual levels is crucial for sustainable improvement in health research knowledge.⁸

Strategies to foster a research culture among medical students include mandatory assignments within electives, research workshops on diverse topics, trainee experience in

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indexed journals, and revising curricula to incorporate research capacity building.⁹ However, the practical application of theoretical research knowledge remains an often-overlooked aspect.

Peer Assisted Learning (PAL) is defined as “learning among the people who are not professional teachers and belong to the same social groupings,” or it is simply defined as “learning among the peers”.¹⁰ PAL is an opportunity for students to be teachers of their colleagues and induces cognitive and social congruence between a learner and a teacher, which can be effective for medical schools with increasing learners but fixed faculty size.¹¹

Studies indicate that peer-assisted learning (PAL) is an effective educational method in medical education, showing promising preliminary outcomes.^{12,13} However, evidence on its feasibility, particularly for clinical research training, remains limited. Available data suggest that medical students generally view PAL favourably, citing academic and psychosocial benefits.¹⁴

The practical efficacy of PAL in medical education is ambiguous. A meta-analysis suggests that its effectiveness may vary with the complexity of topics taught by mentors, raising questions about its broader applicability.¹⁵ Conversely, studies examining academic performance improvements found that PAL significantly enhanced student knowledge compared with traditional methods, such as large-group discussions and faculty-led lectures.^{16,17} Additionally, medical students increasingly favour self-directed learning, interactive sessions, and PAL approaches over conventional didactic teaching.¹⁶

This study aims to explore the efficacy of the PAL teaching modality in the field of clinical research training for medical students by assessing improvement in research knowledge of students being taught via peer-assisted learning. Furthermore, this study also aims to highlight mentee and mentor perceptions regarding the peer-assisted learning program to get a holistic view of the applicability and effectiveness of this teaching modality in helping medical students learn about clinical research and its associated practical aspects.

Methodology

This study aimed to assess the effect of the PAL program on the clinical research knowledge of undergraduate students and to learn about the perceptions of the PAL program and peer teaching methodology among mentors and mentees participating in the program. Ethical approval was obtained from the Institutional Review Board (Ref. No: 431-05/IREF/RMU/2023). The required sample size was determined using the WHO sample size calculator. At the 95% confidence level, power of the test at 90%, and with the hypothesised population mean post-PAL teaching knowledge score being 13.9 and the test value of the population mean post-conventional teaching understanding score being 17.1.¹⁸

The required sample size was 70 cases and 70 controls each. Informed consent was obtained from all participants. A non-equivalent control group pretest–posttest quasi-experimental design was employed. Participants were not randomly allocated to the intervention or control groups. Mentees voluntarily enrolled in the PAL program, whereas controls were selected from students not participating in the program and were matched with the mentee group according to gender and year of study. A total of 82 mentees and 82 controls were included in the study, and all 164 participants completed both the pre- and post-program RKE assessments. Therefore, no RKE data were missing, no participants were excluded because of incomplete assessments, and multiple imputations were not required. All participants were included in the final analysis. Both groups continued to receive the same institutional curriculum-based lectures and group discussions on research methodology throughout the study period. The intervention group additionally received a structured six-month PAL program. Both groups completed the Research Knowledge Evaluation (RKE) questionnaire before and after the six-month study period. Initially, 22 mentors were selected from a pool of applicants based on their research knowledge and previous practical experience; however, one selected mentor withdrew prior to the commencement of the PAL program and did not participate in any of the study activities. The inclusion criteria for mentors were final-year medical students with at least one prior research publication in a peer-reviewed journal. Additionally, 82 mentees were chosen based on their interest in clinical research and enthusiasm for participating in the program. Eligibility criteria for mentees included being a medical student from the 1st to 4th year of study with no previous research publication in a peer-reviewed journal.

Following the selection of mentees, 82 students currently studying in the MBBS program at RMU, who were not part of the PAL program, were selected via simple random sampling using a random number generator. The control group was matched with the mentee group for gender and year of study to reduce potential confounding factors. All participants also participated in group discussions and lectures on research methodology as part of their medical college curriculum. The mentor and mentee selection methodologies are depicted in Figure 1.

The primary exposure variable was participation in the structured PAL programme. PAL participation was defined as enrolment in and participation in the six-month-long structured peer-assisted research training programme. Participants were categorised as PAL mentees (exposed group) or controls (non-exposed group).

The primary outcome was clinical research knowledge, which was measured using the Research Knowledge Evaluation (RKE) score. The RKE consisted of 20 closed-ended questions, with one point awarded for each correct response and zero points for incorrect responses. Therefore, the total score ranged from 0 to 20, with higher scores indicating greater research knowledge. RKE was assessed at baseline before the commencement of the PAL program and again after the completion of the six-month program. The change in the RKE score was defined as the post-program RKE score minus the pre-program RKE score.

The secondary outcomes included participants' perceptions of the PAL program and peer-assisted learning methodology. Mentee perceptions were assessed using a 31-item questionnaire, while mentor perceptions were assessed using a 9-item questionnaire. Items were rated on a five-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree), with higher scores representing greater agreement with the respective statement. For reporting purposes, agreement was defined as a response indicating agreement with the statement, as specified in the questionnaire's scoring approach.

Potential confounding variables considered a priori included gender, academic year, previous research experience, and baseline research knowledge. Gender and academic year were addressed through frequency matching of the controls to the mentees. Previous research experience was recorded at baseline and compared between the groups. Baseline RKE score was measured before commencement of the intervention and was considered when interpreting between-group differences because the groups were not randomly allocated and demonstrated a statistically significant difference in baseline RKE scores. Other potentially relevant factors, including pre-existing research interest and motivation to participate in research, were not formally measured and were therefore considered potential unmeasured confounding sources.

To assess the research knowledge of the mentees and controls, we developed a 20-item questionnaire. The questionnaire was sent to professionals in the field of research education for final amendments to be made. The questionnaire consisted of 20 closed-ended questions with four options per question. A correct answer was awarded 1 point, and wrong answers were awarded 0 points, with a maximum and minimum attainable score of 20 and 0, respectively. The score attained by the control or mentee was termed the Research Knowledge Evaluation Score (RKE). Mentee perceptions regarding the PAL program and the peer-assisted learning methodology were collected using a 31-item questionnaire with a 5-point Likert scale with a ranking ranging from 1 (strongly agree) to 5 (strongly disagree). A 9-item questionnaire with a 5-point Likert scale with a ranking ranging from 1 (strongly agree) to 5 (strongly disagree) was used to assess the perceptions of mentors regarding the PAL program. Perception questionnaires were adapted and modified based on previously published studies.¹⁹⁻²² The questionnaires were sent to professionals in the field of research education for final amendments. The questionnaire was subsequently tested in a pilot study involving 15 participants, and the reliability analysis yielded a Cronbach's alpha of 0.7.

Several potential sources of bias were considered because of the nonrandomized nature of the study. Selection bias was possible because participation in the PAL program was voluntary, and students who chose to participate may have had greater pre-existing interest or motivation for research. To reduce differences between the intervention and control groups, controls were frequency-matched to mentees according to gender and academic year and were selected from students who did not participate in the PAL program. Previous research experience was also assessed and compared between the groups. Baseline RKE scores were measured before the intervention to identify pre-existing differences in research knowledge among the participants. Both groups were exposed to the same institutional research methodology curriculum during the study period, thereby reducing the differences attributable to routine curricular exposure. Assessment bias was possible because blinding of individuals involved in grading was not feasible, and the graders were aware of the participant group allocation. Self-reported perception measures were also potentially subject to response and social desirability biases. These potential sources of bias were considered when interpreting the results.

The Peer Assisted Learning (PAL) program is a structured program created to provide aspiring undergraduate medical researchers with an opportunity to gain practical experience in conducting academic research. The PAL program was a 6-month-long elective program, from 1st June 2023 to 30th November 2023, open to all students studying medicine at Rawalpindi Medical University, Pakistan. Mentees were placed under undergraduate mentors with prior experience in medical research. Mentors were selected after a thorough interview process based on their previous experience in medical research. After the selection process, 21 research groups were created, each comprising a mentor and 3-4 mentees. Each group was instructed to choose a research topic to conduct observational research for the duration of the PAL program. Mentors were instructed to provide their mentees with comprehensive sessions on the multiple aspects of conducting an academic research project following a structured research training plan provided by the organisers of the PAL program (annexure). These sessions comprised in-person and online lectures on the topics highlighted in the research training plan mentioned above. Mentors also guided their mentees regarding practical issues that occur when conducting research and helped them navigate the hurdles that young researchers face when conducting research at the undergraduate level.

A research knowledge evaluation of the mentees was conducted before the commencement and completion of the PAL programme. Mentees' and mentors' perceptions of the PAL programme were also recorded after its completion. A control group, consisting of undergraduate students from RMU who were not partaking in the PAL programme and were matched for gender and year of study, was also created to assess the effectiveness of the PAL programme. The RKE of the control group was also conducted before the commencement and after the completion of the PAL programme. The RKE questionnaire was scored using a standardised answer key. No blinding was employed during the grading process; therefore, individuals involved in grading were aware of the participant group allocation. This has been acknowledged as a potential source of bias and a limitation of this study. The PAL course schedule is shown in Figure 2.

The PAL intervention was delivered according to a structured research training plan developed by the program's organisers. Each research group consisted of one undergraduate mentor and three to four mentees per group. Mentors were expected to cover the topics specified in the standardised training plan through in-person and online sessions and provide practical guidance throughout the research project. The same overall training framework was used by all 21 research groups. Faculty oversight and administrative coordination were provided by the PAL program organisers. The control group did not receive the PAL intervention but continued to receive the routine institutional curriculum on research methodology.

Descriptive statistics of the study population, including gender, year of study, and previous research experience, are displayed in tabulated form. Prior to inferential analysis, the distribution of continuous RKE scores was assessed using the Shapiro–Wilk test and visual inspection of histograms and Q–Q plots. While mentee pre-PAL scores did not significantly deviate from normality ($W = 0.977$, $p = .137$), significant departures from normality were observed in the control pre-PAL scores ($W = 0.953$, $p = .004$), control post-PAL scores ($W = 0.914$, $p < .001$), and mentee post-PAL scores ($W = 0.941$, $p < .001$). As the normality assumption was not met for the RKE score data, non-parametric tests were used to analyse the data. Within-group comparisons of pre- and post-program RKE scores were performed using the Wilcoxon Signed-Rank test, while between-group comparisons were conducted using the Mann–Whitney U test. Statistical significance was set at $p < 0.05$. Because the participants were not randomly allocated and the baseline RKE scores differed between the groups, the pre-existing difference in research knowledge was considered when interpreting the effect of PAL participation. The primary comparison of intervention-associated changes was based on the difference between the pre- and post-program RKE scores in the two groups. Gender and academic year were addressed through frequency matching, and previous research experience was assessed as a potential confounding variable. Pre-existing research interest and motivation were recognised as potential unmeasured confounders because they were not formally measured.

A two-sided p-value of < 0.05 was considered to be statistically significant. Effect sizes and 95% confidence intervals were reported, where applicable. Only participants who completed both pre- and post-program assessments were included in the final analysis; therefore, no imputation of missing data was performed. The responses on the Likert scale in the questionnaire were summarised using the median and standard deviation. SPSS version 28.0 (RRID: SCR_002865) was used for the analysis.

Results

Our study pooled data from 82 participants who took part in the PAL program as mentees and filled in the pre- and post-RKE forms and pre- and post-program perception forms. The participants consisted of 24 (29.3 %) males and 58 (70.7%) females. The mean age of the mentees was 21 years ($SD=1$). Eight (9.8%) of the mentees were from the 1st year, 35 (42.7%) were from the 2nd year, and 39 (47.6%) were from the 3rd year, MBBS. Most of the participants (80.5%) had no prior research experience. Among the 16 (19.5%) participants who had prior research experience, 7/16 (43.8%) had participated in synopsis writing, and 3/16 (18.8%) had taken part in data collection. The demographic details of the participants are presented in Table 1. No significant differences were observed between the groups with respect to previous research experience ($P = 0.200$) or the type of previous research experience (all $P > 0.05$).

Pre- and post-research knowledge evaluation: A total of 164 students (82 mentees, 82 controls) completed the pre- and post-PAL research knowledge evaluation. The mean RKE score of mentees before the commencement of the PAL program was 11.00 ($SD=2.994$), and after completion of the PAL program, the mean RKE score of the mentees was 13.00 ($SD= 3.283$). To evaluate whether there were any changes in research knowledge evaluation (RKE) scores achieved by mentees before and after completing the PAL program, a Wilcoxon Signed-Rank Test was conducted, with the results displayed in Table 2.

Table 1: Mentees and controls demographic data

Characteristics		Mentees (percentage)	frequency	Controls (percentage)	frequency	P
Gender	Male	24 (29.3)		24 (29.3)		-. ^a
	Female	58 (70.7)		58 (70.7)		-. ^a
Academic year	1 st Year	8 (9.8)		8 (9.8)		-. ^a
	2 nd Year	35 (42.7)		35 (42.7)		-. ^a
	3 rd Year	39 (47.6)		39 (47.6)		-. ^a
Previous research experience	Yes	16 (19.5)		10 (12.2)		0.200*
	No	66 (80.5)		72 (87.8)		
Type of experience	Research courses	2 (2.4)		1 (1.2)		1.000**
	Synopsis	7 (8.5)		3 (3.7)		0.328**
	Data collection	3 (3.7)		1 (1.2)		0.620**
	Acknowledgements	2 (2.4)		2 (2.4)		1.000**

^a Controls were frequency matched by gender and academic year; no statistical comparison performed

* Pearson's Chi-Square Test, ** Fisher's Exact Test

Table 2: Comparison of Research Knowledge Evaluation scores

Intragroup Pre & post program RKE score comparison*								
Group comparison	Mean RKE score	Median score	RKE	Z		Effect size (r)	P	95% CI
Mentee pre-PAL vs Mentee post-PAL ^a	Mentee pre-PAL: 11.0	Mentee pre-PAL: 11.0		-3.946		0.31	< 0.001	[1.00, 3.00]
	Mentee post-PAL: 13.0	Mentee post-PAL: 14.0						
Control pre-PAL vs Control post-PAL ^a	Control pre-PAL: 9.4	Control pre-PAL: 9.0		-0.555		0.04	0.579	[-1.00, 0.50]
	Control post-PAL: 9.2	Control post-PAL: 8.5						
Intergroup pre & post program RKE score comparison**								
Group comparison	Mean RKE score	Median score	RKE	Z	U	Effect size (r)	P	95% CI
Mentee pre-PAL vs Control Pre-PAL ^a	Mentee pre-PAL: 11.0	Mentee pre-PAL: 11.0		-3.263	2374	0.25	0.001	[1.00, 3.00]
	Control pre-PAL: 9.4	Control pre-PAL: 9.0						
Mentee post-PAL vs Control post-PAL ^a	Mentee post-PAL: 13.0	Mentee post-PAL: 14.0		-7.216	1178	0.56	< 0.001	[3.00, 5.00]
	Control post-PAL: 9.2	Control post-PAL: 8.5						

^a 0-20 RKE score

*Wilcoxon Signed Ranks Test, **Mann-Whitney U Test

RKE: Research knowledge evaluation

CI: Confidence Interval (Hodges-Lehmann median difference)

The test revealed a statistically significant positive change in RKE scores after taking part in the PAL program, $Z = -3.946$, $P < 0.001$, 95% CI [1.00, 3.00], with a medium effect size ($r = .31$). RKE of the controls was also conducted before commencement and after completion of the PAL program, with mean scores of 9.40 (SD= 3.239) and 9.15 (SD= 2.686), respectively. To evaluate whether there were any significant changes in the research knowledge evaluation (RKE) scores achieved by the controls before the commencement of the PAL program and after its completion, a Wilcoxon Signed-Rank Test was conducted, with results displayed in Table 2. The test revealed a statistically insignificant change in RKE scores after taking part in the PAL program, $Z = -.555$, $P = 0.579$, 95% CI [-1.00, 0.50], with a small effect size ($r = .04$).

The Mann-Whitney U Test was used to evaluate the difference between the pre-PAL program RKE scores. The test revealed significant differences in the pre-PAL RKE scores of Mentees (Median = 11, $n = 82$) and controls (Median = 9, $n = 82$), $U = 2374$, $z = -3.263$, $P = 0.001$, 95% CI [1.00, 3.00], $r = .25$. The mentee and control groups had mean ranks of 94.55 and 70.45, respectively. The Mann-Whitney U Test was used to evaluate the difference between the post-PAL program RKE scores.

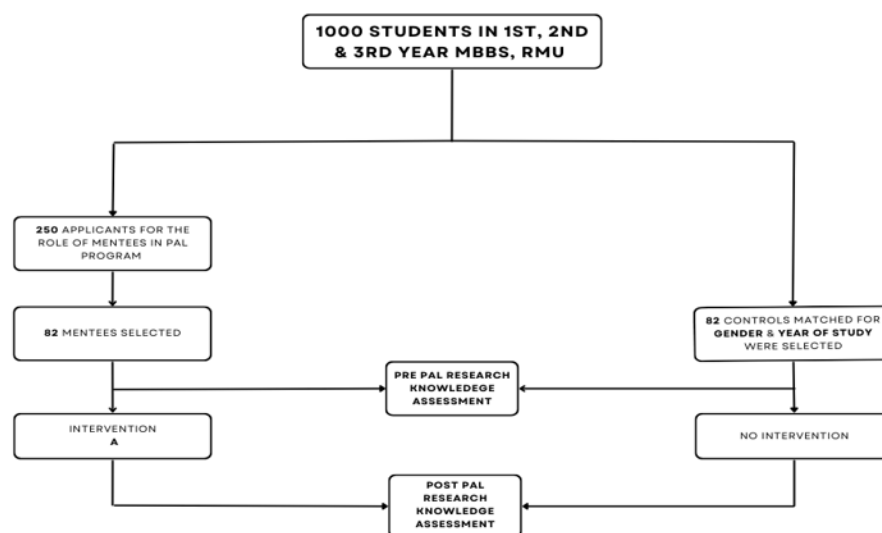
Table 3: PAL program perceptions

Mentee post-PAL perception					
Items ^a	Median	Interquartile range	Standard Deviation	Percentage of agreement	Change from pre-PAL perception (%)
I know how and where to start a research from	2.00	1	0.650	86.6	23.2
I know about the basic components of research	2.00	1	0.582	91.5	33.0
I know how to select a topic that is best suited for me	2.00	1	0.846	78.0	30.4
I know how to search literature properly	2.00	2	0.785	80.5	39.0
I am aware about different study designs	2.00	1	0.908	65.9	43.9
I know how to write a synopsis properly	2.00	2	0.711	81.7	51.2
I know the different techniques and tools of data collection	2.00	2	0.812	63.4	31.7
I know how to analyze research data using SPSS	3.00	1	0.880	37.8	28.0
I know how to write a manuscript	2.00	1	0.997	56.1	41.5
I know about different types of journals and how to publish in one.	3.00	1	0.950	43.9	25.6
I know how to critically read and understand a research article	2.00	2	0.813	80.5	47.6
I know how to design a study questionnaire	2.00	2	0.940	74.4	30.5
I am aware about different sampling techniques	2.00	1	0.814	65.9	47.6
I am aware about research ethics	2.00	1	0.568	93.9	30.5
I am aware regarding criteria of authorship	2.00	2	1.078	69.5	23.2
I know how to calculate sample size for a research	2.00	1	0.994	65.9	47.6
I know how to enter data on spss/ any other statistical software	2.00	1	1.122	59.8	47.6
I know how to analyze data on spss/ any other statistical software	3.00	1	1.006	43.9	35.4
I know about different statistical tests and when to apply them	3.00	2	0.956	36.6	29.3
I know about components of a manuscript	2.00	2	0.861	75.6	48.8
I know how to extract references from literature	2.00	2	0.807	82.9	46.3
I know about different referencing styles	2.00	2	0.828	76.8	42.7
I have knowledge regarding scientific writing	2.00	2	0.807	63.4	9.7
I know about plagiarism and how to correct it	2.00	2	0.894	72.0	23.2
I know how to write an abstract	2.00	2	0.843	78.0	51.2
I know what MESH keywords are and how to use them properly	2.00	2	0.935	69.5	21.9
Peer-assisted teaching is an effective teaching strategy	2.00	1	0.802	87.8	NA
I prefer being taught by a peer tutor than via traditional teaching	2.00	1	0.828	79.3	NA
I am more willing to engage in sessions taught by a peer tutor than during traditional teaching	2.00	1	0.867	78.0	NA
I feel more confident learning from a peer tutor compared to traditional teaching	2.00	1	0.822	76.8	NA
The peer-assisted teaching that I received in this course is sufficient to prepare me to start my own research	2.00	2	0.985	65.9	NA
I would like to become a mentor in the future and train aspiring researchers	2.00	1	0.932	68.3	NA
Mentor perception of PAL program					
Items ^a	Median	Interquartile range	Standard Deviation	Percentage of agreement	
I had the opportunity to consolidate my knowledge on research/ a particular topic	1.00	1	0.805	90.5	
Being a mentor has increased my confidence in my tutoring and presentation skills	2.00	1	0.796	90.5	
I have a better understanding of teamwork and the roles within the team	2.00	1	0.727	90.5	
I am a better role model to my peers	2.00	1	0.811	57.1	
I have developed both personally and professionally	2.00	2	0.981	71.4	
Being a mentor has made me consider an academic career in the future	3.00	2	1.024	33.3	
I think the students benefited from my teaching and mentoring experience	2.00	1	0.680	76.2	
I had support from faculty or other peers (e.g., PAL admins, coordinators)	2.00	2	1.078	61.9	
Overall, I feel I was adequately prepared for this role	2.00	1	0.707	76.2	

^a 0–5 disagree–agree scale.

Percentage of agreement: score >3 on likert scale

SPSS: Statistical Package for the Social Sciences, MESH: Medical Subject Headings, PAL: Peer assisted learning



A. 6 month long, structured peer assisted learning program under an experienced peer mentor

Figure 1: PAL mentors and mentees recruitment methodology

The test revealed significant differences in the post-PAL RKE scores of mentees (Median = 14.00, n= 82) and controls (Median = 8.50, n= 82), $U= 1178$, $z= -7.216$, $P < 0.001$, 95% CI [3.00, 5.00], $r= .56$. The mentee and control groups had mean ranks of 109.13 and 55.87, respectively.

Although the post-program RKE scores were significantly higher among mentees than among controls, this finding should be interpreted in the context of the significant baseline difference between the groups. The results therefore demonstrate an improvement in research knowledge among students participating in the PAL program and a significant between-group difference at post-program assessment, but do not establish an independent causal effect of PAL participation.



Figure 2: PAL program schedule

Mentee perceptions regarding the PAL program: Self-perception of the mentees regarding their research knowledge before the start of the PAL program is displayed in Table 3. The lowest self-perception scores were in knowledge of different statistical tests (7.3% agreement), use of SPSS/ other data analysis software (8.5% agreement), and general knowledge of how to analyse data (9.8% agreement). The highest self-perception scores were in knowledge of how to begin research (63.4% agreement), knowledge about research ethics (63.4% agreement), and knowledge of basic components of research (58.5 % agreement). Overall, the mentees' self-perceived knowledge was low before the PAL program's commencement. Post-PAL program self-perception regarding research knowledge and the peer-assisted learning strategy is displayed in Table 3. There was a substantial increase in mentees' self-perception of

their research knowledge. Mentee perception regarding the peer-assisted learning strategy was also positive, with 72 (87.8%) mentees agreeing that PAL is an effective treatment strategy. 65 (79.3%) mentees preferred peer-assisted learning over traditional teaching methods. 54 (65.9%) mentees agreed that the PAL program was sufficient to help them begin their own research.

Mentor perceptions regarding the PAL program: The perceptions of the mentors regarding the PAL program are displayed in Table 3. 19 (90.5%) mentors found the PAL session to be beneficial for them by helping them consolidate their knowledge and improve their tutoring and presentation skills. Fifteen (71.4%) mentors also reported personal and professional development after completing the PAL program. Seven (33%) mentors considered future careers in academia after mentoring their peers in the PAL program.

Discussion

The present study found that participation in a structured Peer Assisted Learning (PAL) program was associated with improved Research Knowledge Evaluation (RKE) scores and favourable perceptions among undergraduate medical students. However, these findings should be interpreted within the context of the study's design. The mentee group had significantly higher RKE scores than the control group at baseline, indicating that the two groups were not equivalent before the intervention. This difference is particularly important because participation in the PAL program was voluntary; therefore, students who chose to participate may have had greater pre-existing interest, motivation, or familiarity with research than those who did not participate. Consequently, although the increase in RKE scores among mentees and the absence of a significant change among controls suggest a positive association between PAL participation and improved research knowledge, the observed differences cannot be attributed solely to the PAL intervention itself. The findings therefore provide supportive evidence for the potential educational value of structured PAL in clinical research training rather than definitive evidence of a causal effect. The majority of mentees have a positive perception regarding their PAL experience, including favourable views of the learning environment,²³ as well as preferring PAL over traditional teaching strategies. A large number of mentees also found the PAL sessions to be more engaging than traditional teaching techniques. The study also showed a significant increase in RKE scores of mentees undergoing the PAL program, thus highlighting the efficacy of the PAL teaching methodology. This is in concordance with previously conducted studies which found higher evaluation scores in PAL groups as compared to teacher/expert-led learning groups in several aspects of medical education, including teaching research in undergraduates (pre- and post test scores of 19 ± 4 vs. 12 ± 5 , respectively, $p = 0.001$),¹⁶ and post graduate training to improve examination skills (PAL vs. Expert-assisted learning scores of 69.98 ± 5.6 vs. 85.27 ± 5.6 , respectively, $p = 0.000$).²⁴ A significant difference in post-intervention RKE scores between controls and mentees was also observed, highlighting a greater gain in research knowledge among mentees who participated in the PAL program.

The PAL program was also beneficial to the mentors, as evidenced by their perception scores. An overwhelming majority of mentors believed that participating in the PAL session helped them consolidate their previous research knowledge and improve their teaching and tutoring skills. This is in concordance with the systematic reviews on the effectiveness of PAL programs in medical education.¹⁵ Past studies have highlighted that mentors develop teaching skills when guiding their fellow mentees and hence acquire an important skill that helps them develop into ideal and holistic physicians.²⁵ Teaching acumen is also an important part of the selection criteria in many international medical residency programs, as educators consider it an important aspect when screening potential trainees.²⁶ This illustrates how taking part in a structured PAL program to teach research to medical students is highly beneficial for the mentors.

Utilising medical students as mentors fosters a self-sustaining research culture, stimulating growth in both the quantity and quality of undergraduate research in the field. Mentees express gratitude for mentorship, often aspiring to become mentors themselves, as evidenced by our study, in which 68% expressed willingness to volunteer. PAL methodology also cultivates networking opportunities, connecting undergraduate medical students with research communities locally and globally and facilitating future research endeavours.

Despite the numerous positive aspects of PAL, some drawbacks need to be highlighted. A major concern raised by critics of PAL is the potential lack of knowledge of the mentors when compared to traditional teaching faculty. This disparity in knowledge could be a cause of the difference in RKE scores seen between different mentees after the completion of the PAL program. However, our study reported a significant increase in the research knowledge of mentees after the 6-month PAL program, indicating that mentors achieved their teaching goals. Another issue that may arise in PAL programs is the unprofessional teaching environment, which may lead to a lack of discipline among students and a decrease in the teaching efficacy of a PAL program. These shortcomings have also been found in other studies when assessing the efficacy of the PAL methodology.^{27,28} A mixed-method approach with a blend of

traditional and PAL methodologies can help bridge the shortcomings of both teaching methodologies and can be beneficial in achieving teaching objectives.²⁸

This study had certain limitations that warrant consideration in future research on this subject. Despite attempting to have the control and study group participants matched for gender and year of study, a variable that we could not account for was the initial knowledge levels of the control and the study groups. A potential reason for this was the voluntary basis of enrolment for the mentee program, with students having more research interest and, subsequently, research knowledge being more likely to apply for the program. Furthermore, the short-term assessment period of this study precluded the evaluation of the PAL program's long-term effects on participants' research knowledge progression. Despite assurances of anonymity and non-influence on program progress, the presence of assessments and perception questionnaires may have influenced participants to overstate their perceptions. Additionally, the study did not assess functional outcomes, such as publication success, following PAL participation. Furthermore, the impact of mentee motivation on research knowledge improvement could not be thoroughly examined, potentially influencing variations in RKE scores and perceptions of the program.

This study had several limitations. First, the non-equivalent control group pretest–posttest design did not involve random allocation, and the mentee and control groups differed significantly in baseline RKE scores. Although groups were matched for gender and year of study, differences in research interest, motivation, and other unmeasured factors could not be controlled. Voluntary recruitment of mentees may have also introduced selection bias (the volunteer effect), as participants may have been more interested or motivated to learn about research. Therefore, the observed improvement in the RKE scores cannot be attributed solely to the PAL intervention and should be interpreted as an association rather than definitive evidence of causation.

Second, the short-term assessment period did not evaluate whether improvements were sustained or translated into longer-term outcomes such as research participation or publication. Self-reported perceptions may have been influenced by response bias, and the absence of blinding during grading may have introduced a bias in the assessment. Future studies using randomisation or statistical adjustment for baseline differences, along with long-term outcome assessment, are needed to better determine the impact of PAL on research learning and engagement. Despite these limitations, the findings have practical implications for medical education in Saudi Arabia. Structured PAL may offer curriculum planners a potentially feasible approach to expand research training without relying exclusively on faculty-led instruction. This may be particularly relevant for resource-limited medical schools, where increasing student numbers, limited institutional research capacity, and faculty shortages may restrict opportunities for individualised research mentorship. By training senior students or students with prior research experience to mentor junior peers, PAL may help distribute teaching and mentorship responsibilities while simultaneously providing mentors with opportunities to consolidate their knowledge and develop teaching and leadership skills.

The group-based structure used in this study also suggests potential scalability, as one trained peer mentor can support several junior students within a structured research project. Rather than replacing faculty supervision, PAL may be most appropriately integrated as a complementary component of the existing research curricula. For example, foundational concepts and quality assurance could remain under faculty oversight, while peer mentors provide ongoing small-group guidance, practical support, and near-peer mentorship. Such integration may allow institutions to expand experiential research training while making more efficient use of their limited faculty resources. However, successful implementation requires standardised mentor preparation, clearly defined learning objectives, appropriate faculty oversight, and mechanisms to maintain the quality and consistency of peer-delivered instruction.

Conclusions

In conclusion, participation in the structured peer-assisted learning program was associated with improved Research Knowledge Evaluation scores among undergraduate medical students and was positively perceived by both mentees and mentors. However, because of the non-equivalent control group pretest–posttest design, lack of randomisation, and significant baseline differences in research knowledge between groups, these findings should not be interpreted as definitive evidence that PAL alone caused the observed improvements. The results suggest that structured PAL may be a feasible and potentially scalable adjunct to faculty-led research training, particularly in settings with limited faculty and research training resources. Integrating PAL within existing undergraduate research curricula, with appropriate mentor preparation and faculty oversight, may provide an additional strategy for expanding practical research learning opportunities. Further studies using more rigorous designs and longer-term outcome measures are required to determine the causal impact and sustainability of this approach.

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