ORIGINAL ARTICLE

EFFECTIVENESS OF HORIZONTAL PEER-ASSISTED LEARNING IN PHYSICAL EXAMINATION PERFORMANCE

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Background: All students cannot be individually trained in physical examination skills due to faculty and time limitations. Peer-assisted learning (PAL) can solve this dilemma if it is used in undergraduate curriculum. Empirical effectiveness of horizontal peer-assisted learning model has not been reported previously. The objective of this study was to compare horizontal peer-assisted learning (PAL) with expert-assisted learning (EAL) in teaching of physical examination skills. **Methods:** This is a randomized controlled study (Solomon four group design) carried out at a medical school. A total of 120 undergraduate year 5 students were randomized into two groups to undergo training in four areas of physical examination. Stratified random sampling technique was used. Group 1 was trained by EAL while Group 2 by PAL. Half students from both groups were given a pre-test to assess the testing effect. Both groups were given a post-test in the form of an OSCE. Independent samples *t*-test and paired sample t-test were used as tests of significance. **Results:** Group 2 scored significantly higher than Group 1. There was significant difference (p=.000) in mean post-test scores of Group-1 (69.98±5.6) and Group-2 (85.27±5.6). Difference in mean scores was not significant (p=.977) between students who had taken the pre-test and those who had not. **Conclusion:** This study has implications in curriculum development as it provides quantitative evidence indicating that horizontal PAL as a learning strategy can actually replace, rather than augment, expert-assisted learning in teaching clinical skills to undergraduate students.

Keywords: Clinical education; Horizontal PAL; Peer-assisted learning; Quantitative; Assessment; Randomized controlled trial; Solomon's four group design

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INTRODUCTION

It is increasingly becoming evident that novel methods of teaching and learning are needed to effectively impart the requisite competencies to a large number of students by a limited faculty in a specified academic calendar. Learning physical examination skills is a repetitive process that is time-consuming. All students cannot be individually trained in physical examination skills in the limited time available.

Peer-assisted learning (PAL) is a tool that can train the students in self-directed learning[1] while making it possible for them to achieve their learning objectives. Peer-assisted learning has been described as "people from similar social groupings who are not professional teachers, helping each other to learn and learning themselves by teaching".[2] In practice, PAL can be vertical or near-peer, when senior students teach juniors, and horizontal or peer-to-peer, where tutors and tutees belong to the same academic year.[3]

Peer-assisted learning techniques have been used in medical teaching in cognitive,[4] psychomotor and behavioural domains[5,6]. Literature search shows that most studies and training programs have used near-peer model of PAL.[7] A few studies have explored a peer-to-peer PAL model as well[8] but most of them consist of either feasibility studies or surveys of student and faculty perceptions about it.[1,9–11] Peer-learning programs also differ in their scope and ingress into the curriculum. Some institutions employ PAL as an adjunct to the curriculum to enhance learning,[12,13] whereas others have a PAL program embedded in the curriculum[14].

No framework is available to implement a horizontal PAL program[3] to learn clinical skills at undergraduate level. Moreover, in our knowledge, no evidence is available that compares effectiveness of PAL in empirical terms with expert-assisted learning of physical examination skills. We felt that a randomized controlled trial was needed to assess the effectiveness of horizontal[3] PAL in objective terms. This would help curriculum developers in making evidence-based decisions while considering peer-assisted learning. This study compares performance in physical examination of surgery clerkship students trained by horizontal[3] PAL with those trained by expert-assisted learning (EAL).

MATERIAL AND METHODS

The study was carried out in department of surgery of Foundation University Medical College, Islamabad, Pakistan. Students of final year MBBS who were willing to participate, were included in the study. Any student who missed a training or assessment session was to be excluded.

This was a randomized controlled trial to compare physical examination performance of students trained by horizontal[3] PAL with those trained by expert-assisted learning (EAL). Solomon's four group design[15] was used to measure the impact of the pre-test (Figure-1)[16]. Pre-test was essential to our study in order to estimate the amount of learning before intervention but there was risk of test-enhanced learning, testing effect,[16] influencing the study results. This design also enabled post-intervention assessment after an interval of four weeks, necessary to judge sustainable impact of intervention on students' learning in terms of knowledge, skills and behaviors.[15,17]

Stratified random sampling was used to enrol 120 students at 95% confidence interval (80 female and 40 male).[18] Sample size was calculated by OpenEpi calculator.[19,20] Four equal and similar batches were formed by stratification[18] based on gender and academic achievement. Each batch was taught only one out of four clinical examination skills (Figure-1), randomly allotted to it through a draw. Students in each batch were then randomized into two subgroups, using lottery method. Subgroups 1 were taught by EAL and subgroups 2 by PAL. For data analysis, all subgroups 1 (1A, 1B, 1C, 1D) collectively formed Group 1 (Control) and all subgroups 2 (2A, 2B, 2C, 2D) formed Group 2 (Experimental) (Figure-1).

Scoring rubrics were used as data collection instruments. We developed a structured scoring rubric for each physical examination by following the standard textbooks on clinical methods. After the drafts of four different rubrics were prepared we invited opinion of experts to validate them. Validation was meant to find out if the rubrics could actually be operationalized to assess the students in an OSCE exam.[26,32,33] Cognitive pretesting was done to determine face validity in order to ascertain whether the scoring rubrics were easy to understand and to work with. Eight OSCE assessors were asked to rate each item on a scale of 1(Not at all understandable) to 4 (Clearly understandable). An item rated 2 or below by more than two assessors would require revision to make it more understandable. None of the items needed such revision but the time allocation for each station was increased to four minutes on their recommendation. Content validity was determined to ensure that the rubrics actually measured the skills that were meant to be assessed. Eight subject experts and two medical educationalists were asked to rate each item on a scale of 1 (Not relevant) to 4(Highly relevant). Some items were modified after recommendations from experts. Content validity ratio (CVR) for each item in the rubric was calculated by computing the responses of experts using Lawshe's formula[21] given below:

$$CVR = (Ne - N/2) / N/2$$

where N is the total number of raters and Ne is the number of raters who rate an item as essential or relevant. Mean of CVRs of all items is the content validity index (CVI) of that rubric.

Content validity index (CVI) for all four rubrics, determined by mean of CVRs of all items in each rubric, was excellent, ranging between 0.86 and 0.96.

Pilot testing of the rubrics was done twice with a gap of 15 days. The scoring rubrics were pilot tested on eight assessors (2 on each of the four stations) who independently rated 10 students each of year 5 of the batch of 2015 (a year senior to the study population). A total of 40 students participated. Same raters assessed the same groups in Test and Retest. Purpose of pilot testing was threefold: firstly, to determine if the raters had any problems working with the checklists; secondly, to assess time duration for each OSCE station; and lastly, to check the reliability of the assessment rubrics.

Two types of reliability were measured – internal consistency of the rubrics that all items of each rubric belong to the same subject; and reproducibility that students would produce the same result if tested again on the same rubric.[15,22] Cronbach's alpha, used to calculate internal consistency was found to be >0.9 for each rubric. The Kappa statistic was not valid in this study as it is used for categorical data.[23,24] Intra-class Correlation Coefficient (ICC) was used to calculate inter-rater and intra-rater reliability[25,26] and was found to be >0.8 for each rubric.

Ethical review was carried out by two universities involved in the study. Students participating in the study were explained its purpose and significance. They were assured that the training program and assessment of this study was in addition to their prescribed curriculum and will neither affect their learning or schedule, nor would it have any bearing on their end of year assessment. Standardized patients were also informed about the purpose of study and were given the choice to volunteer or refuse their participation.

Scoring on the four rubrics was discussed with the assessors selected for OSCE, in order to ensure standardization of marking. The process of data collection during the trial is illustrated in figure-2.

Both control and experimental subgroups of students were taught separately by same teacher (Table-1). Each PAL subgroup was asked to divide into units of 5 students with one student in each unit chosen by them as their peer tutor (PT). Physical examination was demonstrated to PTs only. Peer tutors practiced it under supervision and perfected the skill to demonstrate it unsupervised. They were then asked to train their own PAL units. One week later, in a short session, a random student from each PAL subgroup was asked to perform the skill in front of the whole batch for formative assessment.

After 4 weeks, all groups took a post-test in the form of an OSCE. Assessors were blinded to the identity of control and experimental groups. Two assessors rated students from both subgroups of each batch, making a total of eight assessors. Data obtained from this OSCE and the pre-test OSCE was analysed with SPSS 23 (Table2).

RESULTS

Independent samples t-test was applied to compare mean percent scores in post-test OSCE of Group-1 – control group trained by EAL, and Group-2 – experimental group trained by PAL. It showed a statistically significant difference (p=0.000) with 95% confidence interval (Figure-3).

Post-test score of students who had taken the pre-test (Batches A and B) was compared with those who had not taken the pre-test. Mean percent score of pre-test students (n=60) was 77.60±9.652 whereas that of non-pre-test students (n=60) was 77.65±9.388. Difference between these two values was not significant (p=0.977).

Comparison of post-test mean score of pre-test students (1A+1B) with non-pre-test students (1C+1D) of Group-1 revealed that mean score of pre-test students (n=30) was 69.83±5.5 whereas that of non-pre-test students (n=30) was 70.13±5.8. Independent samples t-test was applied and the difference was found to be not significant (p=0.838). Similar comparison done in Group-2 revealed that mean percent score of pre-test students (2A+2B) was 85.37±5.86 whereas that of non-pre-test students (2C+2D) was 85.17±5.39. Independent samples t-test showed the difference to be not significant (p=0.891).

Male to female ratio in all batches and subgroups was 1:2. Mean score of male students in post-test OSCE was 79.50±8.96 whereas of female students was 76.69±9.65. Gender difference in mean score was not significant (p=0.126).

Pre-test and post-test scores of batches A and B were analysed and paired sample t-test was applied on mean percent scores. Difference in means of pre-test and post-test scores was 23.1±8.5 (p=0.000). In group-1 this difference was 16.4±4.6 9 (p=0.000) while in group 2 it was 29.8±5.7 (p=0.000).

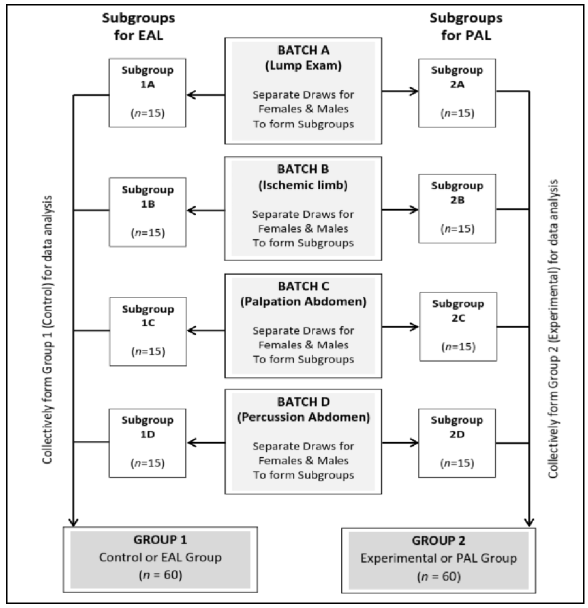

Figure-1: Formation of EAL and PAL groups and subgroups

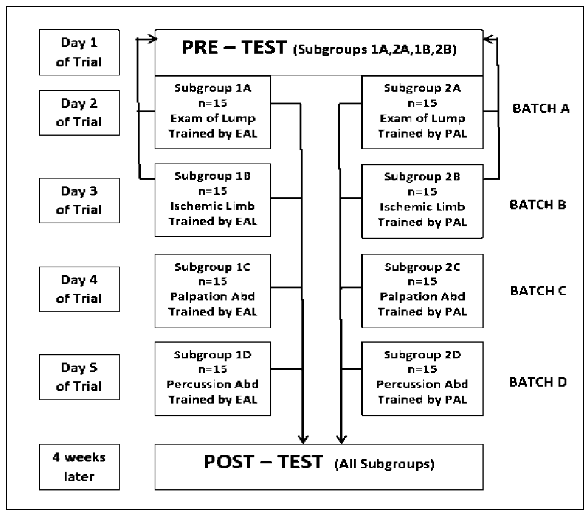

Figure-2: Data collection procedure during the trial

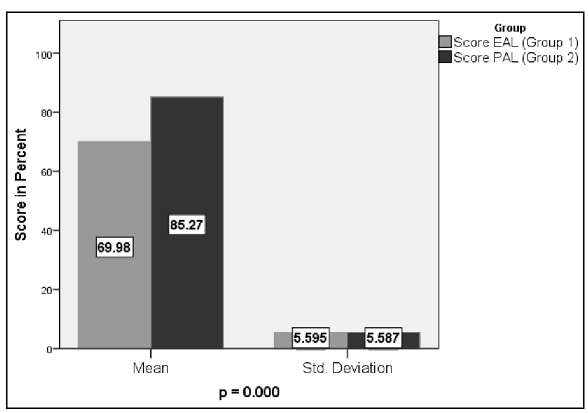

Figure-3: Comparison of mean score of group 1 and 2

Table-1: Features of teaching and assessment of EAL and PAL subgroups

Encounter	Expert-assisted learning (EAL)	Peer-assisted learning (PAL)
Setting	Demonstration room of ward	Demonstration room of ward
Participants	Students of subgroups (1A,1B,1C,1D)	Students of subgroups (2A,2B,2C,2D)
Day 1 of trial (Pre-test OSCE)	Subgroups 1A and 1B	Subgroups 2A and 2B
Day 2 of trial	Subgroup 1A was taught examination of lump	Subgroup 2A was taught examination of lump
Day 3 of trial	Subgroup 1B was taught exam of ischemic limb	Subgroup 2B was taught exam of ischemic limb
Day 4 of trial	Subgroup 1C was taught palpation of abdomen	Subgroup 2C was taught palpation of abdomen
Day 5 of trial	Subgroup 1D was taught percussion of abdomen	Subgroup 2D was taught percussion of abdomen
Instructor role	Demonstration to whole subgroup followed by practice by students	Demonstration to peer-tutors only who practiced under supervision and then taught tutees of their PAL unit
PAL unit	-	5 students
Number of PAL units in a subgroup	-	3
Ratio of peer tutor to tutees	-	1:4
Selection of peer-tutors		Chosen by own PAL unit
Number of sessions per subgroup	1	1
Duration of session	1 hour	1 hour
Post-test OSCE	4 weeks after sessions (All subgroups)	4 weeks after sessions (All subgroups)

Table-2: Analysis of pre-test and post-test scores

Comparison of Mean Scores (Percent) of Post-test		**Statistical Test**
Sum of Group 1 (EAL) (1A,1B, 1C, 1D) (*n*=60)	Sum of Group 2 (PAL) (2A, 2B, 2C, 2D) (*n*=60)	Independent samples t-test
Pretest students 1A + 2A + 1B + 2B (*n*=60)	Non-pre-test students 1C + 2C + 1D + 2D (*n*=60)	Independent samples t-test
Pretest students (EAL) 1A + 1B (*n*=30)	Non-pre-test students (EAL) 1C + 1D (*n*=30)	Independent samples t-test
Pretest students (PAL) 2A + 2B (*n*=30)	Non-pre-test students (PAL) 2C + 2D (*n*=30)	Independent samples t-test
Scores of Male students (*n*=40)	Scores of Female students (*n*=80)	Independent samples t-test
Comparison of mean scores (Percent) of pre-test students in:		**Statistical Test**
Pre-Test	**Post-Test**	
1A + 2A + 1B + 2B (*n*=60)	1A + 2A + 1B + 2B (*n*=60)	Paired samples t-test
1A + 1B (EAL students) (*n*=30)	1A + 1B (EAL students) (*n*=30)	Paired samples t-test
2A + 2B (PAL students) (*n*=30)	2A + 2B (PAL students) (*n*=30)	Paired samples t-test

DISCUSSION

To our knowledge, this is the first study to provide documented evidence that use of horizontal or peer-to-peer[3] PAL improves physical examination skills of undergraduate students. Previous studies on the subject have used a near-peer model of PAL.[4,5,7] Peer-to-peer PAL has the advantage that students of same academic year are utilized in their own teaching, obviating the need to recruit peer-tutors from a senior class who may feel burdened by this additional responsibility, may lose motivation after some time, or may not be focused enough due to their own academic distractions.

Data analysis shows that there is a statistically significant improvement in performance of students trained by PAL, as compared to those trained by traditional EAL. The difference is striking between mean percent scores of PAL group (85.27±5.6) and EAL group (69.98±5.6) (Figure-3).

It is not possible to identify the reasons for the enhanced performance by students of PAL group. There was no difference amongst control and PAL groups in terms of teaching time, group size, gender composition of subgroups and reading resources. Although EAL and PAL subgroups were formed by randomization, choice of each PAL unit of five that formed a peer learning unit was made by students themselves. Peer-tutors were also chosen by them. It can be speculated that this could have led to a sense of competitiveness with others. Another factor could be that PAL students liked the new mode of learning so much that they wanted to get it implemented in the college by practicing more.[26]

Solomon's four group design was used in this study to evaluate any impact on the results of the study due to testing effect.[15] The results showed that this impact was not statistically significant. This aspect was further explored by comparing the mean scores of pretest and non-pretest students within control (EAL) as well as experimental (PAL) groups. The difference was not significant even within the control or experimental group. The reason for absence of testing effect could be that students were unaware of the items on the scoring rubrics as they were not given any corrective feedback after pretest.[27–29] Students were also unaware of the way the raters scored their performance.[30]

As expected, the post-test scores were significantly higher than pre-test scores. Gender bias was obviated as there was no significant difference in scores based on gender.

In our case, rationale for considering PAL in teaching physical examination to undergraduate students was the large number of students, limited time and faculty, and the long hours required to teach clinical skills to every individual student. A common motivation for using PAL as a learning strategy has been to fill gaps in learning identified in curriculum or as an adjunct to support weaknesses in a subject.[31,32] Lack of interest in academic careers among new graduates, has been the motivation in one program.[33]Financial considerations have been reported as a factor in some studies[34] although this might be difficult to justify.

A PAL program requires a leader to organize it. Wadoodi and Crosby[35] have maintained that it should be led by students as it enhances the student-centeredness of the initiative. During the course of this study, we felt that structured organization and smooth implementation of a sustainable program requires it to be led by a faculty member. The faculty leader should plan and implement the program but should not be present in the PAL sessions. This point of view is supported in literature.[33]

Apart from general benefits of a PAL program, there are specific aims of PAL in every institution that has introduced it. Blank *et al*[26] reported that students, who participated in PAL as an adjunct to their routine teaching, performed better in objective assessments than non-PAL controls. Our study not only lends credence to this view, it goes further to provide evidence that PAL students perform better even when the PAL program replaces routine teaching.

Selection of peer-tutors is a subject of debate. Some previous studies maintain that peer-tutors should be selected on the basis of high academic achievement.[30] In our study, each peer-tutor was chosen by participants of PAL unit of five students to which he or she belonged. The students know each other and can judge who may teach them better. This also offers the flexibility to change peer-tutors depending on the skill to be learnt. Selection by students puts a moral responsibility on peer-tutor and quashes any rivalry within PAL unit. This promotes a sense of purpose to perform well. The strikingly high scores of PAL students in our study can be explained by this phenomenon.

The encounter of PAL session needs to be explained to the participants beforehand.[37] It can be easily done in peer-to-peer PAL as peer-tutors and tutees are from same batch of students. The alternate view is that a content structure for the interaction should not be pre-determined and students should follow their own structure.[37] In our view, without some degree of oversight on teaching content, some gaps in learning may occur.[12]

Formative evaluation of PAL is essential. There are reports of simulated patients and staff members being used to observe the proceedings[37] but this can disrupt the PAL environment. Our practice during teaching sessions was to hold a short second session one week after the first one, in which one random peer-tutee from each subgroup was asked to demonstrate the skill. This helped in evaluating the learning without disturbing the PAL session itself.

The concept that students in a PAL program learn better because of cognitive[38] and social congruence[39] of peer-tutors and tutees, has been substantiated in this study. Tutees can interact more freely with peer-tutors to clarify their understanding of a subject. In addition, they can relate more readily with the level of understanding of a peer-tutor.[12]

Literature reports suggest that PAL programs can be implemented with limited resources.[26] This is reflected in our study as no additional resources were employed in terms of finances, teaching material, teaching premises, manpower or time.

This study has implications in that it provides quantitative evidence that PAL students perform better than non-PAL students, particularly in the domain of clinical skills that require a longer time to master. It will help every student to get personalized assistance in learning the skill and decrease the burden of teaching on faculty members. This should be kept in mind during curriculum review.

We have strived to ascribe causality of better outcomes in peer-assisted learning by using a four group design.[15] This is important in terms of generalizing the outcomes of this study.

Main strength of this study is that it has used a horizontal or peer-to-peer model[3] to compare effectiveness of PAL with EAL in teaching clinical skills to undergraduate students. Moreover, use of four group designs in this trial enabled us to find out that testing effect on results was not significant. This underscores the importance of PAL on study outcomes. Another factor that contributes to strength of this study is that no subject of the study dropped out at any stage.

We could have compared the scores of peer-tutors and tutees to analyse if there was any positive impact on the learning of peer-tutors themselves. We did not do that as it was beyond the scope of objectives of this study. It could have provided evidence whether teaching by peer-tutors actually enhances their learning.

Recommendations: There is a scope for further inquiry in the field of peer-assisted learning. Experimental studies need to be carried out to compare horizontal[3] model of PAL with the widely practiced near-peer3 model in teaching of clinical skills.

Nomenclature and definitions in literature on PAL are confusing. It has not been widely agreed yet as to what modalities constitute PAL. Olaussen[3] et al have attempted to clarify the position by suggesting criteria for different types of PAL. It may be worthwhile to make it a reference for universal use.

CONCLUSION

This study has implications in curriculum design. After using a careful and rigorous methodology, the results of this study have provided quantitative evidence indicating that PAL as a learning strategy can actually replace, rather than augment, expert-assisted learning in teaching physical examination skills to undergraduate students. The framework of implementation is simple enough to be replicated in any medical school but specific in details regarding recruitment of peer-tutors and tutees that can affect outcomes.

AUTHORS' CONTRIBUTION

IS was involved in original idea development, collecting and analyzing the data, preparing the draft for this paper, editing drafts, and approving the final draft. UM was involved in original idea development, analyzing the data for member-checking, reviewing and editing all the drafts of this manuscript, and editing and approving the final draft. SS was involved in data collection, data entry and analysis, preparing the draft for this paper, reviewing and editing the final draft of this paper.

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