

# Effectiveness of Problem-Based Learning (PBL) for Teaching-Learning Biostatistics using MS-Excel among Undergraduate Dental Students in Saudi Arabia: A Quasi-Experimental Study

Shreyas Tikare<sup>1\*</sup>, Ali Fahad AlQahtani<sup>1</sup>, Ahmed A AlBariqi<sup>1</sup>, Alezi Infindon Braimoh Eroje<sup>1</sup>, Raghavendra Reddy Nagate<sup>1</sup>, Shankar T Gokhale<sup>1</sup>

<sup>1</sup>Assistant Professor, Department of Periodontics and Community Dental Sciences, College of Dentistry, King Khalid University, Saudi Arabia

Corresponding Author:

Dr. Shreyas Tikare

Assistant Professor,

Department of Periodontics and Community Dental Sciences,

College of Dentistry, King Khalid University, Saudi Arabia

Email: tikane@kku.edu.sa

## ABSTRACT

**Background:** Although the traditional teaching technique (TTT) is a universally adopted education and learning method in the medical field, it has limited prospects in terms of student interaction. Therefore; the PBL method of teaching and learning emerges which focuses on self-learning by problem-solving to acquire knowledge.

**Aim:** To assess the effectiveness of Problem-Based Learning (PBL) for Teaching-Learning Biostatistics using MS-Excel among Undergraduate Dental Students in Saudi Arabia.

**Methodology:** A total of seventy-four students were included in this study after taking an oral consent. A 20-item questionnaire assessing the student's knowledge and skills on biostatistics was developed. The undergraduate students attending the community dentistry course were academically divided into two groups for the practical session. Each group attended the practical session on two separate days. The same groups were randomly assigned as Theory Group (TH) and Problem Based Learning Group (PBL) with 36 and 38 students respectively.

**Results:** The assessment of participants' self-rating VAS score on their knowledge and skills with MS-Excel had the highest mean difference scores in the PBL group (4.7 and 4.8 respectively). The mean knowledge scores after the intervention were significantly higher than the mean scores before intervention in both TH and PBL groups ( $p < 0.05$ ). However, the mean difference in the knowledge scores was high in the PBL group.

**Conclusion:** PBL method was found to be an effective way of delivering statistics knowledge in medical education in comparison to the conventional didactic method. The assessment records of this study established that PBL has an explicit benefit for learner with accurate recall, improvement of logical and decisive thinking and problem-solving expertise.

**Keywords:** Problem-based learning (PBL), Biostatistics, Dental Graduates.

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## INTRODUCTION

The traditional teaching technique (TTT) is the most universally adopted education and learning method in medicinal tutoring, where a large number of students can cater through lectures. It is, however, a passive transmission of knowledge from teacher to student with minimal opportunities for feedback.<sup>1</sup>The focus of our education should be based on how students think, synthesized analyze, and rethink for the application of knowledge in the real world. But in today's scenario education has only centric with correct answers and marks, teachers only ask their students to describe, explain the facts and perform.<sup>2</sup>

Thus, the major concern of various Departments of University and Educational Committee is the academic satisfaction among students. In the current epoch, to overcome these issues, various innovative teaching-learning systems have come up like Problem-Based-Learning (PBL), Team-Based learning, Project-Based, and Case-Based learning.<sup>3</sup>PBL is a technique in which small assemblage conversation is taken by facilitators, with focuses on self-learning by solving problems to acquire knowledge.<sup>4</sup>

PBL strategy is based on student-oriented pedagogy where the students are engaged with problem scenarios that are relevant to the topic, that provide apprentices a prospect to relate their knowledge in a practical manner other than the traditional Lecture-Based Learning (LBL) method.<sup>5</sup>

The concept of PBL started in the mid-60s era at McMaster University (Barrows and Tamblyn 1980), then it turned into an unbeaten educational approach through the medical world.<sup>6</sup>Now PBL, is adopted in several teaching settings including Structural Design, Nursing, Engineering, and Social work, apart from the Medical world.<sup>7</sup>

According to proficiency-based dental education, dental graduates should be knowledgeable in the subject of Community Dentistry, in which "*Biostatistics*" is the important topic to be covered. Thus, the basic knowledge of biostatistics is essential for postgraduate as well as undergraduate biomedical research and its application during practice.<sup>8</sup> The medical and dental students usually come across statistics as a difficult part to understand and this is a worldwide problem among them. The perception of complexity among students in learning biostatistics could be due to its intangible and mathematical nature where didactic method is commonly used for teaching. Thus; the majority of students fail to build a connection between statistical reasoning and scientific inquiry.<sup>9,10</sup>PBL approach might generate interest among undergraduate students regarding biostatistics. Therefore, the objective of this research was to assess the effectiveness of Problem-Based Learning (PBL) for Teaching-Learning Biostatistics among Undergraduate Dental Students in Saudi Arabia

## METHODOLOGY

The present research follows a quasi-experimental study design. This study was conducted among dental undergraduate students at King Khalid University, College of Dentistry, Saudi Arabia. Ethical clearance was obtained from the Institutional Review Board, King Khalid University, College of Dentistry (IRB/KKUCOD/ETH/2021-22/015). Undergraduate programs of this University have learning outcomes about biostatistics in Community Dentistry course in the sixth year (Course code: PDS 613). All students in PDS 613 course were considered eligible for the study and were informed about the research. A total of seventy-four students had enrolled in the course during 2021-2022. All students in the course, who were willing to participate and gave oral consent, were included in the study.

### Data Collection Instrument

A 20-item questionnaire assessing the student's knowledge and skills on biostatistics was developed. The knowledge domain had fifteen multiple-choice questions constructed from various aspects of biostatistics. The topics included were the measure of central tendency and dispersion, collection and presentation of data, hypothesis testing, and correlation analysis. Each correct answer responded would be scored 1 and the wrong answer scored 0 and hence the total knowledge score ranges from 0-15. The questions were checked for face validity by another faculty of Dental Public Health. The knowledge questions were tested for reliability on 10 undergraduate students who had cleared the Community Dentistry course in the last semester and were found to be acceptable (Cronbach's alpha: 0.743). A total

**Effectiveness of Problem-Based Learning (PBL) for Teaching-Learning Biostatistics using MS-Excel among Undergraduate Dental Students in Saudi Arabia: A quasi-experimental study**

of five items on analytical skills required in conducting simple cross-sectional research was developed. Three items out of five had with 5-point Likert response and the other two items had multiple response styles. The 5-point Likert response was given weightage from 1-5 with the highest 5 for 'Strongly Agree' and lowest 1 for 'Strongly Disagree'. In addition to the above items, a few other questions about students' previous experience of the workshop on biostatistics, self-assessment of their biostatistical knowledge, and skills on the visual analog scale (VAS) from 1-10 and difficulty level of the questionnaire was included.

**Intervention groups**

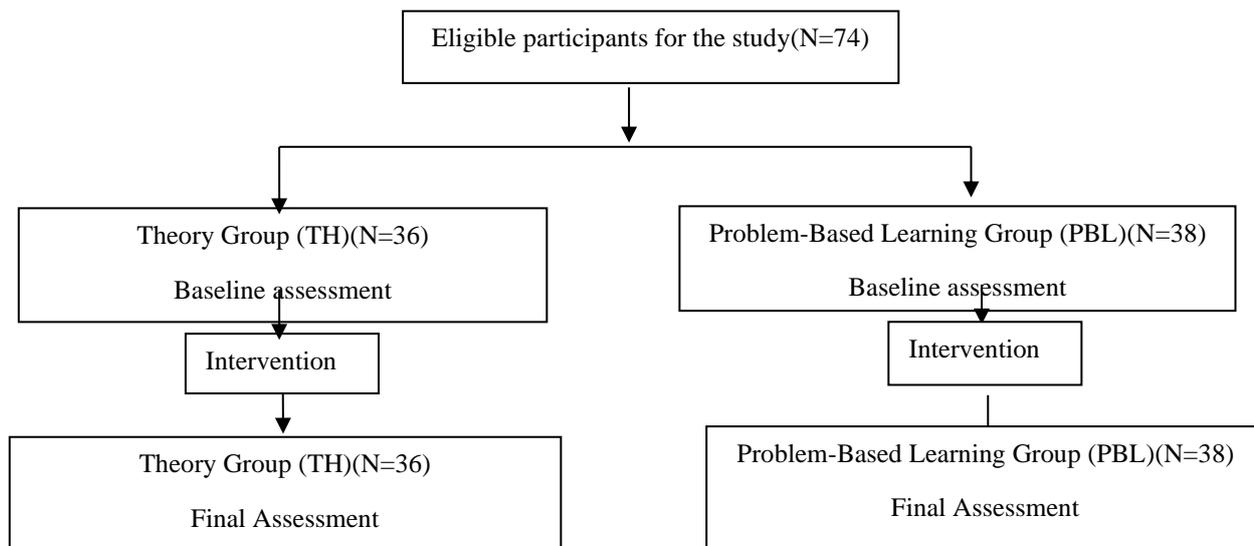
The undergraduate students attending the community dentistry course were academically divided into two groups for the practical session. Each group attended the practical session on two separate days. The same groups were randomly assigned as Theory Group (TH) and Problem Based Learning Group (PBL) with 36 and 38 students respectively.

**Intervention strategy**

A study time of two weeks was scheduled during the early mid-semester of the course module. At this time all students had attended only one lecture on introduction to biostatistics. Baseline knowledge and skills related to biostatistics were assessed in both groups at the beginning of the study using a questionnaire. The students were given 20 minutes to complete the quiz test which was considered adequate. The groups were instructed to face the quiz test even if it was hard to attempt. The TH group received a series of lectures on biostatistics with demonstrations on statistical analysis as MS-PowerPoint slides and oral explanations. The PBL group students were further sub-divided into four groups with nine to ten students in each group with a faculty in dental public health as moderator. The moderators first educated their students on theoretical concepts of biostatistics similar to the TH group with live demonstrations using the MS-Excel program. Students were then given case scenarios with dummy data to find statistical solutions using the MS-Excel program. The moderator upon completing the task would intervene and clear students' doubts if any. At the end of the intervention in both groups, the same questionnaire was used to assess their knowledge and skills in biostatistics.

**Statistical Analysis:** The collected data was stored in the MS-Excel program. SPSS for Windows, Version 16.0. Chicago, SPSS Inc. was used for analyzing the data. The mean, standard deviation, and percentages will be used for descriptive statistics. The student's paired test was used to compare before and after scores within the groups and the student's unpaired test to compare scores between the groups.

**Flowchart study design**



**Results**

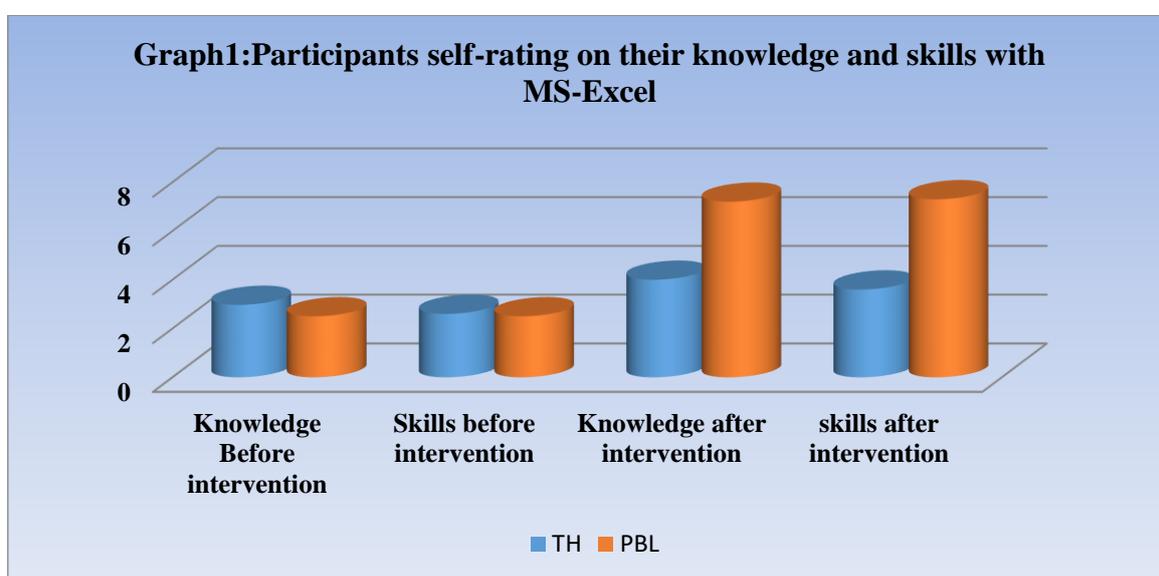
A total of 74 undergraduate dental students participated in this study. The TH group had 36 participants [Male 18(50%) and Female 18(50%)] and the PBL group had 38 participants [Male 18(47%) and Female 20(53%)]. The

**Effectiveness of Problem-Based Learning (PBL) for Teaching-Learning Biostatistics using MS-Excel among Undergraduate Dental Students in Saudi Arabia: A quasi-experimental study**

number of participants who had attended workshops related to biostatistics previously was 4(5.4%) in the TH group and 1(1.4%) in the PBL group. The assessment of participants' self-rating VAS score on their knowledge and skills with MS-Excel had the highest mean difference scores in the PBL group (4.7 and 4.8 respectively)

Table 1: Participants self-rating on their knowledge and skills with MS-Excel

Self-rating on MS-Excel (VAS 1-10)	TH Group			PBL Group		
	Before	After	Mean Difference	Before	After	Mean Difference
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
Knowledge	2.97±1.9	4±2.2	1.03	2.5±2	7.2±2.1	4.7
Skills	2.6±1.5	3.6±2.1	1	2.5±2.2	7.3±1.6	4.8

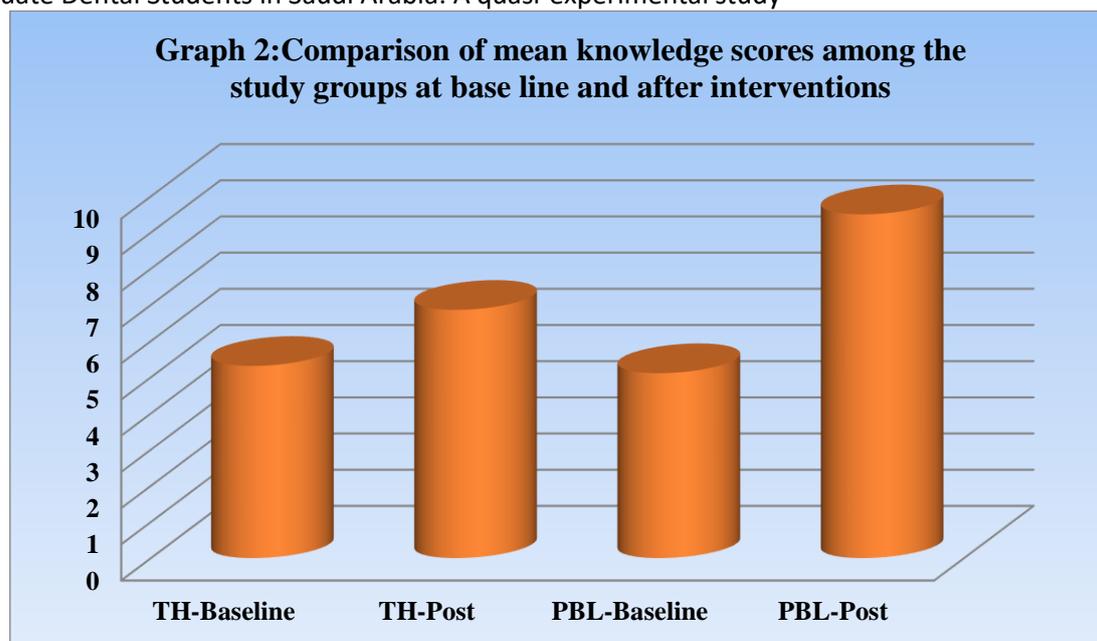


There was no statistically significant difference in mean knowledge scores among the study groups at baseline ( $p>0.05$ ). The mean knowledge scores after the intervention were significantly higher than the mean scores before intervention in both TH and PBL groups ( $p<0.05$ ). However, the mean difference in the knowledge scores was high in the PBL group (Table 2 & Graph 2).

Table 2: Comparison of mean knowledge scores among the study groups at baseline and after interventions

Groups	N	Mean	SD	Mean Diff.	df	T-value	P-value
TH-Baseline	36	5.31	1.19	0.99	72	0.487	0.628
PBL-Baseline	38	5.11	2.18				
TH-Baseline	36	5.31	1.19	1.55	35	-4.525	0.000*
TH-Post	36	6.86	1.68				
PBL-Baseline	38	5.11	2.18	4.39	37	-9.029	0.000*
PBL-Post	38	9.50	2.48				

\*Statistically significant at 5%



The participant’s skills in preparing tables and graphs, choosing the right ‘Statistical Test’ using MS-Excel and the ability to interpret the results for any ‘Tests of Significance’ in a published article in the PBL group were found to have higher total Likert scale values than compared to TH group .

Table 3: Participant responses to questions on their skills with MS-Excel before and after intervention in TH group

		Total Likert Score	Strongly Disagree N(%)	Disagree N(%)	Neutral N(%)	Agree N(%)	Strongly Agree N(%)
TH- Before	I think I have adequate skills in preparing tables and graphs using MS-Excel	80	8(22.2%)	16(44.4%)	8(22.2%)	4(11.1%)	0(0%)
	I think, I can choose the right ‘Statistical Test’ for my research	80	8(22.2%)	15(41.7%)	10(27.8%)	3(8.3%)	0(0%)
	I think, I can interpret the results for any Tests of Significance in a published article	80	8(22.2%)	15(41.7%)	10(27.8%)	3(8.3%)	0(0%)
TH- After	I think I have adequate skills in preparing tables and graphs using MS-Excel	87	7(19.4%)	13(36.1%)	10(27.8%)	6(16.7%)	0(0%)
	I think, I can choose the right ‘Statistical Test’ for my research	90	3 (8.3%)	17(47.2%)	11(30.6%)	5(13.9%)	0(0%)
	I think, I can interpret the results for any Tests of Significance in a published article	97	3(8.3%)	11(30.6%)	16(44.4%)	6(16.7%)	0(0%)

## Effectiveness of Problem-Based Learning (PBL) for Teaching-Learning Biostatistics using MS-Excel among Undergraduate Dental Students in Saudi Arabia: A quasi-experimental study

Table 4: Participant responses to questions on their skills with MS-Excel before and after intervention in PBL group

		Total Likert Score	Strongly Disagree N(%)	Disagree N(%)	Neutral N(%)	Agree N(%)	Strongly Agree N(%)
PBL- Before	I think I have adequate skills in preparing tables and graphs using MS-Excel	67	18(47.4%)	12(31.6%)	7(18.4%)	1(2.6%)	0(0%)
	I think, I can choose the right 'Statistical Test' for my research	66	20(52.6%)	10(26.3%)	6(15.8%)	2(5.3%)	0(0%)
	I think, I can interpret the results for any Tests of Significance in a published article	68	20(52.6%)	8(21.1%)	8(21.1%)	2(5.3%)	0(0%)
Post-PBL	I think I have adequate skills in preparing tables and graphs using MS-Excel	137	1(2.6%)	2(5.3%)	13(34.2%)	17(44.7%)	5(13.2%)
	I think, I can choose the right 'Statistical Test' for my research	136	1(2.6%)	1(2.6%)	15(39.5%)	17(44.7%)	4(10.5%)
	I think, I can interpret the results for any Tests of Significance in a published article	134	1(2.6%)	1(2.6%)	16(42.1%)	17(44.7%)	3(7.9%)

The number of participants who perceived being able to calculate mean, median, mode, standard deviation, and inter-quartile range using MS-Excel after the intervention was overall higher in the PBL group. Similarly, the number of participants who perceived they can perform the following statistical test independently using MS-Excel after the intervention was overall higher in the PBL group.

Table 5: The participants who perceived being able to calculate and perform the following statistical test independently using MS-Excel

Skills	Response options	TH Group (N=36)		PBL Group (N=38)	
		Before N(%)	After N(%)	Before N(%)	After N(%)
I think, I can calculate:	Mean	16(44.4%)	30(83.3%)	20(52.6%)	32(84.2%)
	Median	18(50%)	29(80.6%)	12(31.6%)	29(76.3%)
	Mode	14(38.9%)	28(77.8%)	10(26.3%)	32(84.2%)
	Standard Deviation	3(8.3%)	12(33.3%)	6(15.8%)	32(84.2%)
	Inter-quartile range	3(8.3%)	6(16.7%)	0(0%)	12(31.6%)
	Cannot calculate any	8(22.2%)	3(8.3%)	11(28.9%)	0(0%)

I think, I can perform the following statistical test independently:	Student's Paired t-test	0(0%)	12(33.3%)	0(0%)	34(89.5%)
	Student's Unpaired t-test	0(0%)	4(11.1%)	0(0%)	34(89.5%)
	ANOVA	0(0%)	1(2.80%)	0(0%)	33(86.8%)
	Pearson Correlation	0(0%)	5(13.90%)	0(0%)	25(65.8%)
	Cannot calculate any	36(100%)	17(47.2%)	38(100%)	0(0%)

The percentage of participants who found the quiz easy after intervention in the TH group was 16.6% as compared to 55.3% in the PBL group.

Table 6: Participants self-rating of quiz before and after intervention in both groups

	TH Group (N=36)		PBL Group (N=38)	
	Before N(%)	After N(%)	Before N(%)	After N(%)
Extremely Difficult	15(41.7%)	5(13.9%)	21(55.3%)	3(7.9%)
Moderately Difficult	15(41.7%)	13(%)	6(15.8%)	6(15.8%)
Slightly Difficult	3(8.3%)	12(33.3%)	8(21.1%)	8(21.1%)
Slightly Easy	3(8.3%)	3(8.3%)	3(7.9%)	13(34.2%)
Easy	0(0%)	3(8.3%)	0(0%)	8(21.1%)
Extremely Easy	0(0%)	0(0%)	0(0%)	0(0%)

### Discussion

The present study was conducted to assess the effectiveness of Problem-Based Learning (PBL) for Teaching-Learning Biostatistics using MS-Excel among Undergraduate Dental Students in Saudi Arabia. In this study a total number of 74 undergraduate dental students participated among them, the Theory (TH) group had 36 participants [Male 18(50%) and Female 18(50%)] and in the Problem-based learning (PBL) group had 38 participants [Male 18(47%) and Female 20(53%)]. A similar study was conducted by Bihari A et.al, in India; in which 98 final year medical students were divided into two groups, 'Group A' had 48 participants who underwent conventional lecturing whereas "Group B" had also 48 participants who underwent Problem- Based learning approach to recognize the various areas of Biostatistics.<sup>11</sup>

This study found that there was no statistically significant difference in the mean knowledge scores among both the study groups at baseline ( $p > 0.05$ ). The mean knowledge scores after the intervention were significantly higher in the both PBL group and the TH group ( $p < 0.05$ ), however, the mean difference was higher in PBL group (4.39) as compared to the TH group (1.55). Comparable results were found by Bihari A et.al; he found that when students of Group A and B came into view after the examination, Group A (TTT) students obtained significantly fewer marks as compared with Group B (PBL) students, in all heads for instance objective, descriptive, and viva voce.<sup>11</sup> In the same way; Kaufman et al., also accounted that the PBL students were achieved higher performance at the final professional level.<sup>12</sup>

As per the present study, the participant's skills in preparing tables and graphs, choosing the right 'Statistical Test' using MS-Excel, and the ability to interpret the results for any 'Tests of Significance' in the PBL group were found to have higher total Likert scale values than compared to TH group. The percentage of participants who found the quiz easy after intervention in the TH group was 16.6% as compared to 55.3% in the PBL group. Following the present study, Hwang and Kim<sup>13</sup> and McParland Monica et al;<sup>14</sup> also set up that the PBL group students had a higher level of

## Effectiveness of Problem-Based Learning (PBL) for Teaching-Learning Biostatistics using MS-Excel among Undergraduate Dental Students in Saudi Arabia: A quasi-experimental study

knowledge than that of students in the lecture group and they concluded that the PBL program upshot appreciably superior assessment performance than the traditional teaching.

In the present study, the number of participants who had attended workshops related to biostatistics previously was 4(5.4%) in the TH group and 1(1.4%) in the PBL group. The assessment of participants' self-rating VAS score on their knowledge and skills with MS-Excel had the highest mean difference scores in the PBL group (4.7 and 4.8 respectively). Several studies also reported that to enhance knowledge and applicability of biostatistics, self-ruling learning approaches should be helpful by using easy-to-read handbooks having relevant examples. Problem-based learning techniques<sup>16-17</sup> and dynamic softwares<sup>18,19</sup> are recommended consecutively to make the topic remarkable.

According to Adeleye OA and Ofili AN; 29.7% of students reported difficulty in understanding statistics and 66.7% was unacceptable to different educational method of statistics. They concluded that to overcome this problem and to make the subject interesting PBL is a one-stop key. Similarly; an author Shahabudin et.al<sup>15</sup>; also reported Problem based learning technique helps the students for better accurate recall. Additionally, a systematic review and meta-analysis were conducted and found that the dental tutoring by the PBL system has an affirmative outcome on both theoretical as well as in practical test grades. For that reason, PBL is considered finer than the traditional lecture-based method. On the whole, the verdict of this study showed that PBL unquestionably is a better teaching-learning method when compared to lecture-based learning especially in the stipulation of Biostatistics.

### CONCLUSION AND RECOMMENDATIONS

This study wraps up with the agreement that the Problem-Based Learning (PBL) for Teaching-Learning Biostatistics using MS-Excel gave excellent results as compared with traditional lecture-based learning. Problem-Based-Learning is associated with giving students realistic recall, analytical and critical thinking, and problem-solving skills for a better approach. Since the medical and dental education council is aspiring with a focus on competency in education, self-directed learning among students is a top-notch priority. Therefore; the PBL method should be adopted universally.

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