Research Square

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Instructor-Led Versus QCPR App-Based Training for Chest Compression Skills Among Final-Year MBBS Students: A Pragmatic Educational Study

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Abstract

Background

High-quality cardiopulmonary resuscitation (CPR), particularly effective chest compressions, is essential for improving survival after cardiac arrest. Developing competency in Basic Life Support (BLS) among undergraduate medical trainees remains a key educational priority. However, conventional training methods often lack objective performance assessment. Recent advances in simulation technology, such as QCPR-enabled manikins, provide real-time feedback on CPR quality. This approach offers a more standardized and effective method for enhancing BLS skills.

Objective

To compare the effectiveness of instructor-based learning (IBL) and QCPR app-based learning (ABL) in improving chest compression skills among final-year MBBS students. The study aims to evaluate whether app-based, feedback-driven training offers additional benefits over conventional instructor-led methods in enhancing CPR performance.

Methods

This pragmatic educational study included 80 final-year MBBS students, who were allocated into instructor-based (IBG) and app-based (ABG) groups (n = 40 each). After completing a standardized e-BLS module, all participants underwent hands-on CPR training using a QCPR-enabled manikin. Students in the IBG received feedback directly from instructors, whereas those in the ABG practiced independently with real-time feedback provided by the QCPR application. Chest compression performance was assessed using objective QCPR metrics, along with independent evaluation through video-based expert assessment. In addition, participants' perceptions and learning experiences were explored to better understand the acceptability and perceived effectiveness of both training approaches.

Results

A significantly greater proportion of participants in the instructor-based group (IBG) achieved the guideline-recommended compression rate compared to the app-based group (ABG) (65% vs 27.5%, p = 0.02). No significant difference in compression depth was observed between groups using QCPR-derived metrics. However, video-based expert assessment indicated better compression depth performance in the ABG (75% vs 30%, p = 0.001). Other performance parameters, including chest recoil and overall scores, were comparable between the two groups. Participants in both groups reported high levels of confidence and satisfaction with their respective training approaches.

Conclusion

Instructor-led training appears to be more effective in helping learners achieve the recommended compression rate, while app-based learning may offer advantages in improving compression depth. These findings suggest that each approach supports different aspects of CPR performance. Therefore, a blended training model that integrates both instructor guidance and real-time app feedback may provide a more comprehensive and effective strategy for CPR skill acquisition in undergraduate medical education.

Introduction

High-quality cardiopulmonary resuscitation (CPR) — particularly effective chest compressions — is a cornerstone of Basic Life Support (BLS) and strongly influences survival after cardiac arrest (1)(2). Medical graduates are frequently first responders in hospital settings; therefore, undergraduate curricula must ensure competence in basic resuscitation skills (3)(4). Despite decades of emphasis on resuscitation training, retention of psychomotor skills is variable and declines rapidly without refresher training (5)(6). Advances in simulation and feedback technologies (e.g., QCPR-enabled manikins and app-based real-time metrics) promise objective assessment and individualized feedback that may enhance learning and scalability of BLS education.

Traditional instructor-led training provides real-time corrective guidance and contextual judgement that may be crucial for achieving guideline-recommended performance (rate, depth, recoil) (7)(8). Conversely, app- or video-based self-learning offers standardization, repeatability and wider reach — advantages in resource-limited settings — and has shown comparable outcomes in several studies for skill acquisition (9)(10). However, evidence remains mixed as to which modalities are superior for specific compression metrics, and how human rater evaluations compare to manikin/app feedback.

This study compared Instructor-Based Learning (IBL) and QCPR App-Based Learning (ABL) for teaching chest compressions to final-year MBBS students, assessing objective manikin metrics, rater evaluations, overall quality scores and participants' perceptions. The aim was to determine whether app-based feedback alone can match instructor-led training in producing guideline-compliant chest compressions and to identify complementary strengths of each approach.

Methods

Study Design and Participants

This study was designed as a pragmatic, non-randomized experimental educational trial conducted among final-year MBBS students at tertary care hospital at rural area of central Gujarat. The pragmatic nature of the study was intended to reflect real-world educational settings and training conditions.

Eligible participants included final-year MBBS students who had completed a minimum of four weeks of pediatric clinical posting and had undergone prior theoretical exposure to Basic Life Support through the Indian Academy of Pediatrics (IAP) e-BLS (e-Sanjeevani) moduleCPRE Sanjeevani [Internet]. YouTube; [cited 2026 Apr 11]. Available from: http://www.youtube.com/@cpresanjeevani (11) .Students who provided written informed consent were enrolled in the study.

Inclusion criteria

Final-year MBBS students who had completed a pediatric clinical posting of at least four weeks and had successfully completed the IAP e-BLS (e-Sanjeevani) module were included in the study, irrespective of their test scores.

Exclusion criteria

None

A total of 80 students were recruited over a one-year period from February 2024 to January 2025. Participants were initially selected through convenience sampling from the available cohort and were subsequently allocated into two equal groups (n = 40 each): the Instructor-Based Group (IBG) and the App-Based Group (ABG) (6). Group allocation was performed to ensure comparable group sizes, although complete randomization was not strictly enforced due to the pragmatic design.

Ethical approval

for the study was obtained from the Institutional Ethics Committee prior to commencement. All participants were informed about the study objectives and procedures, and confidentiality of data was ensured throughout.

Intervention Protocol

All participants first completed a standardized online BLS training module (AIIMS Patna—e-Sanjeevani) to ensure a uniform baseline of theoretical knowledge. After a one-week interval, they participated in hands-on CPR training using the BLS Junior QCPR manikin. The practical session was conducted under two different instructional approaches to allow comparison of learning methods.

Instructor-Based Group (IBG)

Participants in this group underwent supervised, instructor-led training facilitated by a trained instructor. Continuous real-time feedback was provided, including verbal cues, correction of hand positioning, and guidance on maintaining appropriate compression rate and technique. Emphasis was placed on achieving guideline-recommended parameters for compression rate, depth, and complete chest recoil. The interactive format enabled participants to clarify doubts and promptly correct errors during practice.

App-Based Group (ABG)

Participants in this group engaged in self-directed practice using the same QCPR manikin integrated with a mobile application that provided real-time, objective feedback. The application displayed key performance metrics, including compression rate, depth, and recoil, allowing participants to independently monitor and adjust their technique. No instructor guidance or correction was provided during the session, ensuring that learning was entirely driven by the feedback system.

Statistical Analysis Plan

Descriptive statistics were used to summarize baseline characteristics of the participants. Comparative analysis between the two groups (IBG vs. VBG) was performed using Chi-square tests for categorical variables. The significance level was set at $p < 0.05$. Outcome variables such as CARDIO score and rater evaluations were compared to assess effectiveness of the training modalities.

Results

Participant Characteristics

A total of 80 students completed the study, with 40 participants in each group. The gender distribution in the Instructor-Based Group (IBG) was 27 males and 13 females, while the App-Based Group (ABG) included 23 males and 17 females. Baseline characteristics, including prior exposure to BLS training, were comparable between the two groups, indicating homogeneity at baseline.

Objective Performance Outcomes (QCPR Metrics)

Compression Rate

A significantly higher proportion of participants in the IBG achieved the guideline-recommended compression rate of 100–120 compressions per minute compared to those in the ABG (65% vs 27.5%). This difference was statistically significant ($\chi^2 = 11.314$, $p = 0.02$), indicating superior performance of instructor-led training in maintaining appropriate compression rate as assessed by objective manikin data.(Table 1)

Table 1
Distribution of participants based on their CPR skill assessment through various parameters

Parameter	Category	IBG (n = 40)	ABG (n = 40)	Total (n = 80)	χ^2 value	p-value
Compression Rate (per min)	Inadequate	14 (35%)	29 (72.5%)	43 (53.75%)	11.314	0.02*
	Adequate	26 (65%)	11 (27.5%)	37 (46.25%)		
Mean Compression Depth (mm)	Inadequate	9 (22.5%)	10 (25%)	19 (23.75%)	0.069	1.00
	Adequate	31 (77.5%)	30 (75%)	61 (76.25%)		
Total QCPR Score	1–25%	4 (10%)	5 (12.5%)	9 (11.25%)	2.747	0.253
	26–50%	8 (20%)	14 (35%)	22 (27.5%)		
	51–75%	28 (70%)	21 (52.5%)	49 (61.25%)		
	76–100%	0	0	0		
Good Release (%)	1–25%	11 (27.5%)	14 (35%)	25 (31.25%)	2.11	0.549
	26–50%	11 (27.5%)	6 (15%)	17 (21.25%)		
	51–75%	6 (15%)	8 (20%)	14 (17.5%)		
	75–100%	12 (30%)	12 (30%)	24 (30%)		
Good Depth (%)	1–25%	7 (17.5%)	5 (12.5%)	12 (15%)	1.374	0.712
	26–50%	3 (7.5%)	4 (10%)	7 (8.75%)		
	51–75%	4 (10%)	7 (17.5%)	11 (13.75%)		
	75–100%	26 (65%)	24 (60%)	50 (62.5%)		

Compression Depth

Analysis of QCPR-derived compression depth revealed no statistically significant difference between the two groups. The proportion of participants achieving high-quality depth performance (75–100% of compressions within recommended depth) was comparable (IBG: 65% vs ABG: 60%; $\chi^2 = 1.374$, $p = 0.712$), suggesting similar effectiveness of both training modalities for this parameter when assessed objectively.(Fig. 2)

Chest Recoil (Release)

There was no statistically significant association between training method and QCPR-assessed chest recoil (good release) among participants ($\chi^2 = 2.11$, $p = 0.549$). The distribution of participants across the four performance categories (1–25%, 26–50%, 51–75%, and 75–100%) was comparable between the IBG and ABG groups. Similar proportions of participants in both groups achieved higher levels (75–100%) of adequate chest recoil.

Composite QCPR Score

A greater proportion of participants in the IBG achieved higher composite QCPR scores (51–75% range) compared to the ABG (70% vs 52.5%). (Fig. 1) This suggests that instructor-guided training may contribute to more consistent overall performance across multiple CPR quality indicators, although statistical significance for this comparison was not observed.

Video-Based Expert Assessment

Independent evaluation of recorded performances by expert raters demonstrated findings that differed in certain aspects from objective QCPR metrics.

A significantly higher proportion of participants in the ABG were rated as achieving adequate compression depth compared to the IBG (75% vs 30%; $\chi^2 = 16.241$, $p = 0.001$).(Fig. 2) In contrast, participants in the IBG were more likely to achieve appropriate compression rates, consistent with findings from QCPR-based assessment.

This divergence between objective and subjective assessments suggests that differences in measurement modalities—sensor-based quantification versus visual estimation—may influence evaluation outcomes.

Participant Perceptions

Participant feedback indicated high levels of satisfaction with both training approaches.More than 90% of participants in each group reported confidence in their ability to perform chest compressions following training. Similarly, over 90% rated the clarity of feedback as adequate.

A large majority of participants in both groups (95%) reported that hands-on training with the QCPR manikin improved their CPR technique. There were no statistically significant differences between the groups in terms of perceived effectiveness of training, clarity of feedback, or confidence levels (Table 2).

Table 2
Distribution of participants based on their Perceptions regarding CPR training for effective training.

Variable	Category	IBG (A)	ABG (B)	Total	Chi-square test	p value
The duration of the training was appropriate for learning the technique effectively	Inadequate	0	1(2.5%)	1(1.25%)	1.01	0.314
	Adequate	40(100%)	39 (97.5%)	79(98.75%)		
I feel confident in performing chest compression after this training	Inadequate	2(5%)	2(5%)	4(5%)	0.347	0.841
	Adequate	37(92.5%)	36(90%)	73(91.25%)		
	No response	1(2.5%)	2(5%)	3(3.75%)		
The feedback provided during training was clear &helpful	Inadequate	1(2.5%)	2(5%)	3(3.75%)	0.721	0.697
	Adequate	38(95%)	36(90%)	74(92.5%)		
	No response	1(2.5%)	2(5%)	3(3.75%)		
The training method was effective in helping me understand proper chest compression technique	Inadequate	2(5%)	2(5%)	4(5%)	0.0001	1.000
	Adequate	38(95%)	38(95%)	76(95%)		
The hands on with QCPR manikin improved my compression technique	Inadequate	2(5%)	2(5%)	4(5%)	0.0001	1.000
	Adequate	38(95%)	38(95%)	76(95%)		

Overall, both training modalities were well accepted and demonstrated effectiveness across multiple domains of CPR skill acquisition.

Discussion

This study highlights the complementary strengths of instructor-led and app-based QCPR-assisted training for improving chest compression skills among final-year MBBS students. Instructor guidance appears particularly important for temporal aspects of CPR, such as achieving the recommended compression rate, likely because instructors can provide rhythm cues, correct timing errors, and reinforce appropriate pacing during practice (12). **In contrast, app-based training offers consistent and objective feedback on parameters such as compression depth and recoil, enabling learners to refine their technique through repeated, self-directed practice. This may explain the better depth performance observed in the app-based group. These findings are in line with previous studies**

suggesting that technology-assisted or self-directed learning can be as effective as, or even superior to, instructor-led methods for certain psychomotor skills, while instructor involvement remains valuable for tasks requiring judgement and process-oriented guidance.

The observed discrepancy between QCPR-derived metrics (which showed no significant difference in compression depth) and video-based rater assessments (which favored the ABG) highlights the influence of the assessment method used (13)(14)(15). While manikin sensors provide objective and precise measurements of compression depth, video-based evaluation relies on visual estimation, which may be influenced by observer perception and camera angles. It is possible that visible aspects of technique, such as body posture and arm positioning, contributed to a perception of better depth in the ABG during video review. This difference underscores the potential for subjective bias in visual assessments. Therefore, combining objective manikin-based metrics with structured expert evaluation may offer a more comprehensive assessment of CPR performance and learning outcomes.

Practical implications for curriculum design

Given the high acceptability and practical advantages of app- and video-based learning—such as scalability, standardization, and reduced faculty time—these approaches may be effectively incorporated as core components for initial skill acquisition and periodic refresher training. However, instructor-led sessions continue to play a crucial role in reinforcing timing, integrating clinical context (including scene assessment and team coordination), and addressing subtle errors in technique. A blended training model, combining pre-class app- or video-based learning with in-class, instructor-facilitated practice using QCPR manikins, may therefore offer the most balanced and effective approach. Such a strategy is likely to leverage the strengths of both modalities and optimize BLS skill development among undergraduate medical students.

Limitations

This study has several limitations. The single-center design and relatively small sample size (n = 80) may limit the generalizability of the findings. Performance was assessed immediately after training, without longitudinal follow-up to evaluate skill retention, which is important given the known decline in CPR skills over time. Although rater assessments were conducted in a blinded manner, they remain inherently subjective and may have been influenced by video quality and camera angles. Additionally, the use of convenience sampling and the potential for Hawthorne effects may affect the external validity of the results. Future multi-center randomized studies with larger sample sizes, longer follow-up, and the use of standardized combined objective and video-based assessment methods are warranted.

Conclusion

Among final-year MBBS students, instructor-based training was more effective in achieving guideline-recommended compression rates, while app-based QCPR feedback was associated with better rater-assessed compression depth and recoil. Both approaches were well accepted and demonstrated

effectiveness across multiple domains, highlighting their complementary roles. These findings support the use of a blended training model that combines app- or video-based modules for repeated, standardized learning with instructor-led sessions for individualized, real-time feedback. Such an approach offers a practical strategy to enhance BLS competency in undergraduate medical education. Ongoing refresher training and further research exploring long-term skill retention and translation into clinical practice are recommended.

Declarations

Ethics approval and consent to Participate :

Ethical approval was obtained from the Institutional Ethics Committee of Bhaikaka University (IEC/BU/148/Faculty/05/203/2025). Written informed consent was obtained from all participants prior to inclusion in the study.

Consent for publication:

Not applicable.

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Author Contribution

Dr Purvi conceptualized and designed the study , supervised data colllection, did the statistical analysis , critically reviewed and revised the manuscript Dr Gaurav designed the data collection , carried out the initial analysis , and drafted the initial manuscript Dr Krutika and Dr Deepali designed the study , coordinated and supervised data colllection , and critically reviewed and revised the manuscript for important intellectual content. Dr Hardee and Dr Jaint helped in Data collection .

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Availability of data and materials :

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Figures

FIGURE 1: Comparison of Rater-based CPR Performance Between IBG and ABG

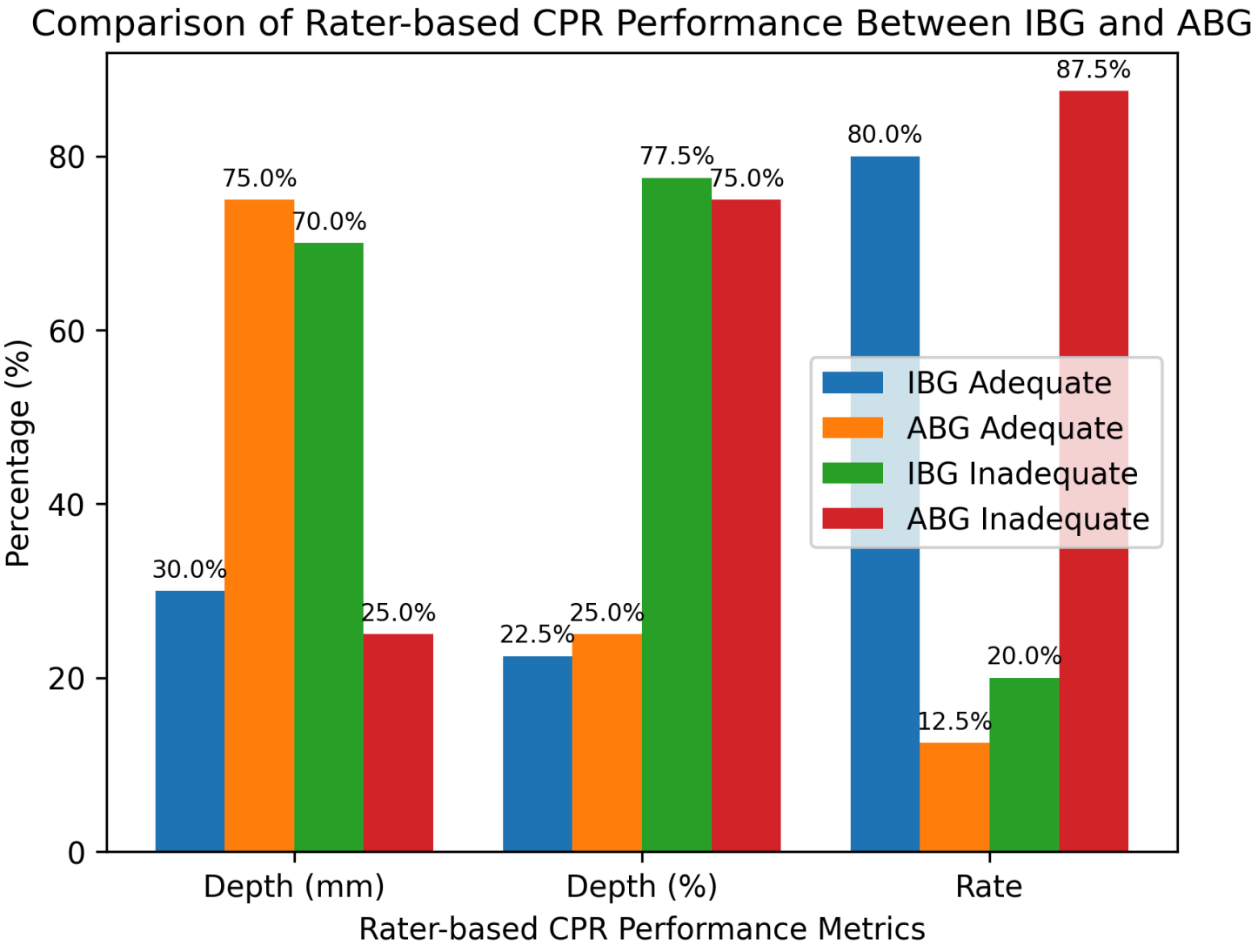


Figure 1

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FIGURE 2: Comparison of Compression Rate and Depth Assessed by QCPR App and Human Rater Between IBG and ABG Groups

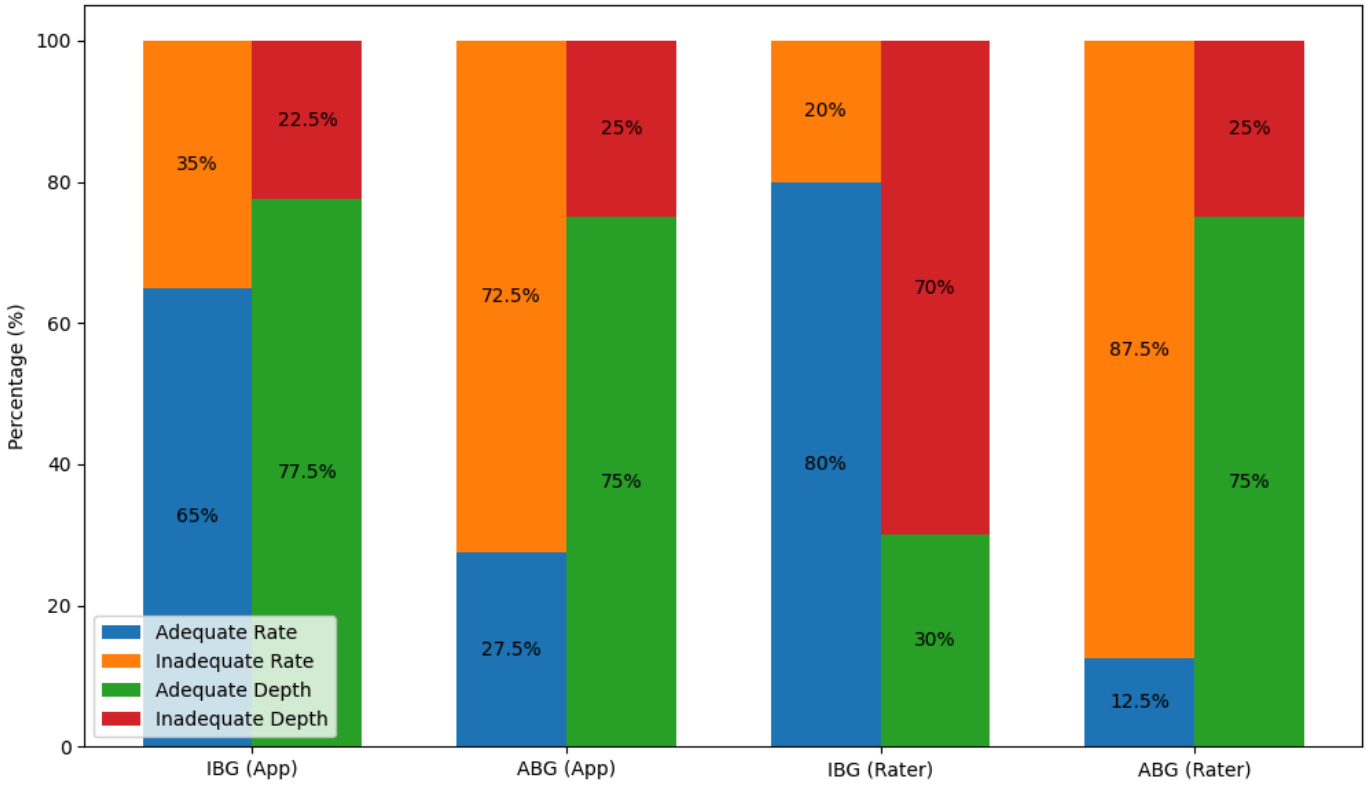


Figure 2

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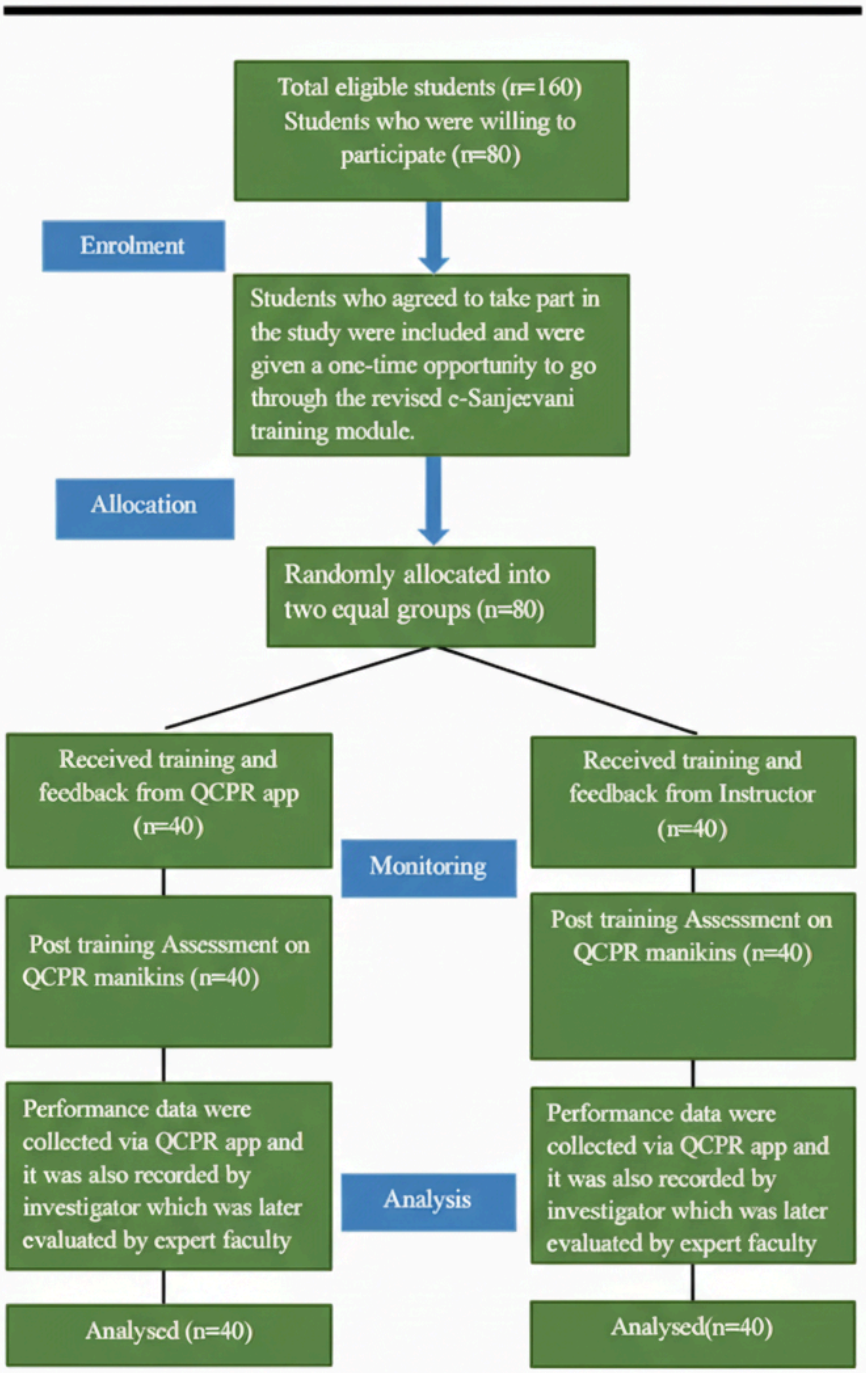


Figure 6: Flowchart of present study

Figure 3

Flowchart of the study