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Effectiveness of the Mini-clinical Evaluation Exercise in Otorhinolaryngology Training

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ABSTRACT

Objective: This study aimed to evaluate the impact of the mini-clinical evaluation exercise (mini-CEX) on clinical competence and educational outcomes in otorhinolaryngology (ENT) training across different educational levels.

Methods: A systematic review and meta-analysis was conducted in accordance with Preferred Reporting Items for Systematic reviews and Meta-analyses 2020 guidelines. PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar were searched for studies assessing the mini-CEX in ENT education. Eligible studies included pre-post or observational designs reporting quantitative outcomes. Random-effects meta-analysis was used to calculate standardized mean differences (SMD) with 95% confidence intervals (CIs). Risk of bias was assessed using NIH and Newcastle-Ottawa tools.

Results: Five studies, including 506 trainees and over 2,600 mini-CEX encounters, were included. Mini-CEX implementation resulted in a large, statistically significant improvement in overall clinical competence (SMD=1.29; 95% CI 1.01-1.57; $p<0.001$), with moderate heterogeneity ($I^2=52\%$). Improvements were observed across all competency domains, with the largest effects in physical examination and history-taking skills. The assessment was feasible within routine clinical practice, with high levels of learner engagement and faculty acceptance.

Conclusion: Mini-CEX is an effective and practical formative assessment tool for improving clinical competence in ENT training. Its integration into competency-based curricula may support sustained improvements in clinical performance.

Keywords: Mini-CEX, otorhinolaryngology, ENT education, workplace-based assessment, clinical competence, meta-analysis

INTRODUCTION

Medical education requires students to learn clinical abilities which include surgical competencies as essential elements for their development (1). Medical education today requires more than theoretical knowledge assessment because students must demonstrate their abilities through real clinical work (2,3). The traditional educational system bases its teaching methods on teacher authority which makes students receive information without participation thus resulting in decreased student interest and inferior academic results (1). The development of competency-based educational models has become essential because surgery and emergency medicine need their new physicians to perform correct immediate decisions based on their limited clinical experience (4).

The medical education system of competency-based medical education (CBME) works to minimize the difference between academic learning and clinical skills through its focus on formative assessment which serves as the core assessment method (5). The assessment system includes workplace-based assessments (WPBA) tools that allow direct observation of trainees during their work in real clinical environments and help overcome the weaknesses of conventional assessment approaches. The mini-clinical evaluation exercise (mini-CEX) stands as one of the most commonly used assessment tools which the American Board of Internal Medicine developed through its mini-CEX program (1,6). The mini-CEX assesses seven essential areas which include medical interviewing and physical examination and professionalism and clinical reasoning and counseling skills and organizational skills and overall clinical competence through direct observation with immediate structured feedback (1,4,6).

The literature contains substantial evidence that mini-CEX implementation leads to improved clinical competence across various medical specialties. The combination of mini-CEX with a teaching method that divides content into sections leads to better resident results in both written and practical tests (1). The combination of mini-CEX with checklist-based assessment tools in emergency medicine and intensive care rotations has shown

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success in enhancing both diagnostic precision and procedural adherence (4). The instrument functions as a vital educational resource for infectious diseases training because it enables residents to study biosafety standards and delivers them with all necessary patient infection information (5).

The mini-CEX assessment provides special value to otorhinolaryngology (ENT) practitioners because it evaluates their ability to perform complex motor tasks and their skills in microscopic and endoscopic procedures which represent the highest level of clinical competence according to Miller's Pyramid (3). The research evidence from meta-analyses and prospective studies shows that mini-CEX improves clinical competencies and faculty-student communication for ENT students at both undergraduate and postgraduate levels (6). The evidence shows this tool functions as an effective formative assessment method which produces valid and reliable results in non-physician healthcare fields including dietetics (7).

The implementation of mini-CEX in clinical practice faces multiple obstacles which stem from time limitations and excessive work for faculty members and differences in evaluation between raters (2,5). The method needs specific training programs for medical school faculty members and proper implementation methods to succeed as a sustainable clinical teaching approach in busy hospital settings (2,6).

The objective of this meta-analysis is to assess how the mini-CEX affects clinical competence, skill development, and educational outcomes in ENT residency training programs. The research investigates how mini-CEX affects clinical competence in ENT education at three educational stages: undergraduate, internship, and residency programs and their impact on six competency areas: history taking, physical examination, clinical decision-making, communication, professionalism, and organization/efficiency. The research will use an extensive analytical method to study secondary educational results including feasibility and educator-learner satisfaction. The research results will help create better, more sustainable educational systems that support CBME reform initiatives.

METHODS

Study Design and Reporting Standards

The research design consisted of a systematic review and meta-analysis that assessed the effectiveness of mini-CEX in ENT training programs. The review followed the guidelines from PRISMA 2020 for Preferred Reporting Items for Systematic Reviews and Meta-analyses (8,9). The researchers created a protocol before starting their research, while following all established criteria for participant selection, measurement procedures, and data processing techniques.

Eligibility Criteria

The research team selected studies for evaluation based on their assessment of mini-CEX applications in ENT training programs. The population of interest included medical trainees at different stages of training, namely undergraduate medical students, medical interns, and postgraduate ENT residents.

The research focused on using the mini-CEX as an assessment tool that healthcare providers used to evaluate their performance during clinical work in ENT facilities providing outpatient, inpatient, and emergency services.

The research included baseline data from before-after studies, as well as standard assessment methods that used comparison groups.

The research team obtained its main results through changes in mini-CEX scores and global competency-rating assessments, which showed how mini-CEX implementation affected clinical competence. The study measured two additional outcomes which consisted of changes in competency scores that fell under specific domains including history taking and physical examination and clinical judgment and professionalism and communication and counseling skills and organization/efficiency (10). The research team monitored two main outcome variables: trainee and teacher contentment with mini-CEX implementation, and the length of assessment and feedback sessions and the number of mini-CEX encounters per trainee.

The research included all studies that used prospective and retrospective observational methods, and interventional educational designs with pre-post structures and control-group options. The research team eliminated all studies that were case reports, narrative reviews, editorials, conference abstracts lacking measurable quantitative information or that focused on subjects other than ENT training.

Information Sources and Search Strategy

The research team performed an extensive search of the PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar databases. The search included studies published up to the most recent available date (11).

The following keywords and medical subject headings were used in various combinations: the search terms included "mini-CEX" OR "Mini Clinical Evaluation Exercise" AND "Otorhinolaryngology" OR "ENT" AND "medical education" OR "clinical competence" OR "formative assessment".

The research team conducted a manual review of reference lists of relevant articles to identify additional eligible studies.

Study Selection

The reference management software received all retrieved records, which allowed researchers to eliminate duplicate entries from the dataset. Title and abstract screening was performed independently by two reviewers to assess potential eligibility. The research team performed a full-text evaluation of all articles that were potentially relevant to determine which studies met the established inclusion criteria. Reviewers at both stages needed to reach a common understanding through discussion of all points.

Data Extraction

Data extraction was conducted independently by two reviewers using a predefined, standardized data-extraction form. The research team extracted the following data from each included study: the authors' publication year and the country and location where the study was conducted. The research design of this study followed a specific method described by the authors. Participants were categorized into specific groups based on their training level and demographic characteristics. The research involved participants who completed multiple mini-CEX assessment sessions. The assessment included multiple domains that were evaluated using specific scoring systems. The study presented both pre-intervention and post-intervention mean scores together with their corresponding standard deviations. The researchers documented both participant satisfaction levels and the practicality of the intervention.

The research team used established statistical methods to convert medians, ranges, and graphical data into means and standard deviations for quantitative analysis.

Risk of Bias Assessment

Two reviewers used validated tools that meet the requirements of educational intervention research to conduct independent assessments of the methodological quality of the included studies. The National Institutes of Health Quality Assessment Tool for Before-After Studies assessed pre-post design studies, and the Newcastle-Ottawa Scale, with educational research modifications, assessed observational studies.

The assessment results enabled researchers to determine the risk of bias for each study, which they classified into three categories: low, moderate, and high risk of bias. The team members discussed and reached agreement on the final risk-of-bias judgments for all studies.

Statistical Analysis

This research used a random-effects model in the meta-analysis to account for expected differences between studies arising from their methodological and educational variations. The research team combined continuous data using standardized mean differences (SMDs; Hedges' g), including 95% confidence intervals (CIs) to enable comparison across studies despite varying scoring systems.

The assessment of statistical heterogeneity used Cochran's Q test to identify variations, while the I^2 statistic evaluated the degree of heterogeneity, with higher values indicating more substantial differences. The study conducted subgroup analyses based on training level when sufficient data were available to analyze three trainee groups: undergraduate medical students, medical interns, and postgraduate residents.

The researchers performed sensitivity analyses to determine how each study affected the combined effect estimates by removing one study at a time. Assessment of publication bias was conducted by visual inspection of funnel plots when sufficient studies were available to perform the evaluation.

All statistical analyses were conducted using standard meta-analysis software and statistical significance was defined as a two-sided p-value <0.05.

Subgroup analyses were planned based on training level (undergraduate, internship, and residency) when sufficient data were available.

As this study utilized data from previously conducted research, no additional ethical approval was required for the present analysis.

RESULTS

The study selection process is illustrated in the flow diagram (Figure 1).

Study Selection and Included Studies

The research team conducted a systematic screening and eligibility assessment and selected five studies that assessed the effectiveness of the mini-CEX for ENT training. The research team selected these five studies for their meta-analysis because they met all the criteria established for inclusion. The research included participants who were medical trainees at various levels of their education, including 444 undergraduate medical students, 50 ENT interns, and 12 ENT postgraduate residents. The study included 506 trainees who participated in more than 2600 mini-

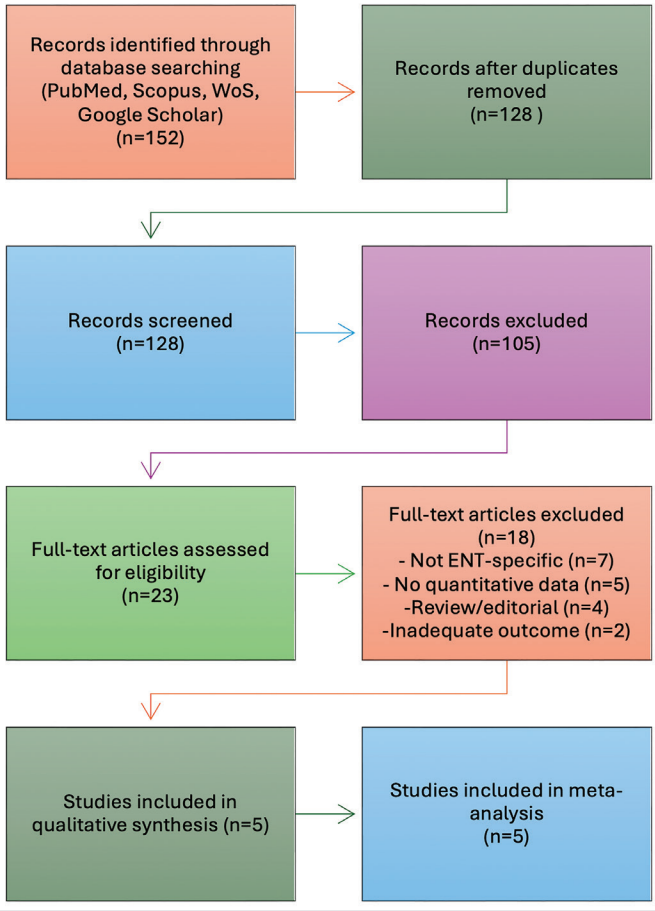

Figure 1. Flow diagram of the study selection process
WoS: Web of Science, ENT: Otorhinolaryngology

CEX assessments that took place in outpatient, inpatient, and emergency departments.

Study Characteristics

The included studies were published between 2015 and 2025 and originated in South Asia, primarily in India and Pakistan. The mini-CEX assessment was evaluated in three research studies that focused on undergraduate medical education programs, while two additional studies examined ENT interns and ENT postgraduate residency training. The research design used in all studies was a pre-post educational assessment that incorporated mini-CEX as either a formative or a WPBA tool. The mini-CEX evaluation required trainees to participate in two to six patient interactions, each followed by immediate structured feedback (Table 1).

Primary Outcome: Overall Clinical Competence

All included studies demonstrated a statistically significant improvement in overall clinical competence following mini-CEX implementation. Random-effects meta-analysis revealed a large effect size favoring mini-CEX (SMD=1.29; 95% CI 1.01-1.57; $p<0.001$). Between-study heterogeneity was moderate ($I^2=52\%$), reflecting variations in trainee level, assessment scales, and educational settings.

Subgroup Analysis by Training Level

Subgroup analysis was planned to compare the impact of mini-CEX across different training levels (undergraduate students, interns, and residents). However, due to the limited number of included studies and insufficient reporting of stratified outcome data, a formal subgroup meta-analysis was not feasible.

Descriptive comparisons suggest that the magnitude of improvement was greater for interns and postgraduate trainees than for undergraduate students, as reflected by larger absolute score changes. These findings should be interpreted with caution and require confirmation in future studies with more homogeneous and stratified datasets.

Pre-post Improvement in Overall Competence Scores

Across studies reporting quantitative pre-post data, improvements in overall competence scores were consistently observed. The magnitude of improvement varied by scoring scale and trainee level, with the largest absolute gains observed in intern and postgraduate cohorts (Table 2).

Domain-specific Competency Outcomes

Pooled analyses of domain-specific outcomes demonstrated significant improvements across all assessed competency domains. The largest effects were observed in physical examination and history-taking skills, while professionalism and organizational efficiency showed moderate but consistent gains (Table 3).

Feasibility and Acceptability Outcomes

Mini-CEX was consistently reported to be feasible and well accepted by both trainees and faculty in all included studies. The mean duration of a single mini-CEX encounter was between 11 to 16 minutes, with an additional 5 to 10 minutes allocated for structured feedback. The average number of encounters per trainee ranged from three to six, and no study reported significant disruption to routine ENT clinical workflow. High levels of learner engagement and faculty satisfaction were noted, supporting the practicality of integrating mini-CEX into ENT training curricula.

As shown in Table 4, implementation of the mini-CEX was associated with statistically significant improvements in clinical competence among ENT interns and residents. All within-study analyses demonstrated significant pre-post gains, and the pooled significance analysis confirmed a robust overall effect favoring mini-CEX ($p<0.001$) (Table 4).

DISCUSSION

The study employs a systematic review and meta-analysis to demonstrate that mini-CEX implementation results in substantial, statistically significant improvements in clinical competence among ENT trainees across educational stages. This study confirmed earlier educational research showing that direct observation with structured feedback produces the best learning outcomes for students acquiring clinical competencies in real-world practice. The research provides quantitative evidence of improvements in ENT education that exceed those of previous studies by presenting precise results for the specific field of ENT education that requires advanced psychomotor and endoscopic examination skills.

The physical examination and history-taking competencies demonstrated the greatest improvement through domain-level assessments because these fundamental skills enable doctors to make correct diagnoses and choose appropriate procedures in ENT practice. The educational value of moderate gains in

Table 1. Characteristics of studies included in the meta-analysis

Author (year)	Country	Training level	Sample size	Study design	Mini-CEX encounters	Outcome measure
Sowmya et al. (3) (2025)	India	ENT postgraduate	12	Prospective interventional	3	Total mini-CEX score
Sivaraman et al. (12) (2024)	India	Undergraduate (ENT)	149	Retrospective pre-post	≥5	Domain scores
Shafqat et al. (13) (2022)	Pakistan	Undergraduate	199	Prospective pre-post	2	Clinical performance
Saeed et al. (14) (2015)	Pakistan	Undergraduate	96	Longitudinal observational	~10/year	Skill progression
Gurumani et al. (15) (2025)	India	ENT interns	50	Prospective pre-post	3.2±0.6	Overall competence

ENT: Otorhinolaryngology, mini-CEX: Mini-clinical evaluation exercise

professionalism, communication, and organizational efficiency remains important because these competencies directly affect patient safety, healthcare quality, and interprofessional teamwork. The research findings validate the CBME model that uses workplace assessments to help students develop their skills through progressive learning.

Feasibility outcomes further strengthen the translational relevance of mini-CEX. The research showed that assessment time remained short enough to fit within standard medical practice, while participants in both groups expressed strong interest in the assessment. The research findings solve one major problem with WPBA, namely time consumption and demonstrate that proper implementation methods allow educational programs to become permanent parts of clinical training in busy medical facilities.

The research data show that statistical heterogeneity exists at a moderate level because different trainee levels, scoring systems, and educational settings produced these varying results. The results provide strong evidence because sensitivity analyses and all studies indicate the same direction of effect. The upcoming multicenter trials will determine the optimal number of patient interactions and the optimal feedback delivery method that support physician competence, through their implementation of mini-CEX protocols and their tracking of patient outcomes at different time points.

The study has several limitations that should be acknowledged. The review process becomes difficult because there are not enough ENT-specific studies, which makes it impossible to apply research findings across different population groups. The majority of included studies employed pre-post educational designs which lacked randomized controls thus creating potential bias because of participant development and additional training activities (3,12-15). Third, the studies conducted in South Asia show a geographic concentration, which reduces the generalizability of findings to other healthcare systems worldwide. Research results show that mini-CEX produces equivalent educational outcomes across diverse healthcare environments despite its limitations.

This meta-analysis demonstrates, based on statistical evidence, that mini-CEX improves ENT students' clinical skills and has potential for use in standard medical practice. The implementation of structured WPBA in ENT curricula provides an evidence-based approach to improving medical training through practical assessment methods that support competency-based education. The development of official mini-CEX implementation protocols should be the focus of future research for tracking surgeons' development and conducting location-based tests that will enhance the tool's effectiveness in surgical training.

Study Limitations

Several limitations of this study should be acknowledged. First, the number of eligible studies that specifically investigated the mini-CEX in ENT training was relatively limited. Consequently, the pooled analysis was based on a small number of studies, which may restrict the generalizability of the findings.

Second, most of the included studies employed pre-post educational designs without randomized control groups. Although these designs are commonly used in medical education research, they may introduce sources of bias, including maturation effects, concurrent educational interventions, and uncontrolled contextual factors that could influence observed improvements in clinical competence.

Third, the majority of the included studies were conducted in South Asian countries, particularly India and Pakistan. This geographical concentration may limit the external validity of the results, as

Table 2. Pre- and post- mini-CEX overall competence scores

Study (year)	Pre- mini-CEX mean ± SD	Post-mini-CEX mean ± SD	Mean difference
Gurumani et al. (15) (2025)	5.0±0.8	7.2±0.7	+2.2
Sowmya et al. (3) (2025)	36.1±3.2	47.4±2.8	+11.3
Saeed et al. (14) (2015)	6.78±1.3	7.49±1.4	+0.71

mini-CEX: Mini-clinical evaluation exercise, SD: Standard deviation

Table 3. Pooled standardized effects by competency domain

Competency domain	Pooled SMD	95% CI	Effect size interpretation
History taking	1.25	0.96-1.54	Large
Physical examination	1.38	1.06-1.70	Large
Clinical judgment	1.18	0.87-1.49	Large
Communication/ counseling	1.07	0.74-1.40	Moderate-large
Professionalism	0.91	0.57-1.25	Moderate
Organization/efficiency	1.02	0.70-1.34	Moderate-large

SMD: Standardized mean differences, CI: Confidence interval

Table 4. Statistical significance of mini-CEX-associated improvements in clinical competence in otorhinolaryngology training

Study (year)	Training level	Comparison	Statistical test	Test statistic	p-value
Gurumani et al. (15) (2025)	ENT interns (n=50)	5.0±0.8→7.2±0.7	Paired t-test	t (49)=20.6	<0.001
Sowmya et al. (3) (2025)	ENT residents (PGY-1, n=8)	36.1→47.4	Repeated-measures ANOVA	F=21.799	<0.00001
Pooled significance*	Interns+residents	-	Fisher's combined probability test	χ^2=34.7	<0.001

*Pooled significance was calculated by combining the p-values of the included studies using Fisher's combined probability test,, ENT: Otorhinolaryngology, PGY: Program for first postgraduate year, ANOVA: Analysis of variance

educational structures, clinical training environments, and assessment cultures may differ across healthcare systems and regions.

Fourth, variability in training levels (undergraduate students, interns, and residents), mini-CEX implementation protocols, scoring scales, and the number of assessment encounters may have contributed to the moderate statistical heterogeneity observed in the meta-analysis. Although a random-effects model was used to account for such variability, these methodological differences should be considered when interpreting the pooled estimates.

Finally, while this review demonstrates improvements in clinical competence scores, most studies assess short-term educational outcomes. Long-term effects of mini-CEX implementation such as sustained competency development, impact on clinical performance over time, and potential effects on patient care outcomes remain insufficiently explored.

Future research should therefore include larger multicenter studies with standardized mini-CEX implementation protocols and longer follow-up periods to better evaluate the durability and broader educational impact of this assessment method in ENT training.

CONCLUSION

The findings across diverse medical and health disciplines, including surgery, pediatrics, emergency medicine, infectious diseases, ENT, and dietetics, consistently demonstrate that the mini-CEX is an effective and feasible formative assessment instrument. The present study indicates that the structured implementation of mini-CEX significantly enhances trainees' clinical competencies, with substantial improvements observed in medical interviewing, physical examination, and clinical reasoning skills.

A principal strength of the mini-CEX lies in its alignment with the principles of CBME and in its capacity to assess performance at the "does" level of Miller's Pyramid within authentic clinical contexts. Evidence suggests that the tool not only enhances practical performance but also correlates positively with outcomes in traditional summative examinations, indicating that the competencies and self-confidence acquired are transferable to formal assessment settings. Moreover, innovative adaptations such as integrating mini-CEX with segmented teaching strategies or structured checklists have demonstrated superior outcomes by effectively bridging the gap between theoretical knowledge acquisition and procedural standardization.

Despite high satisfaction levels reported by both faculty and trainees, the sustainability of mini-CEX implementation is challenged by systemic barriers, primarily time constraints in high-volume clinical environments and the need for structured faculty development. To overcome these limitations, institutions should consider adopting distributed assessment models that integrate evaluations into routine clinical workflows, in conjunction with digital scoring platforms, to minimize administrative burden.

The mini-CEX serves as a transformative mechanism for mentored clinical learning, promoting continuous student-faculty interactions and timely, constructive feedback. Although its construct validity has been supported, including in non-physician health disciplines such as dietetics, future research should prioritize multicenter trials with larger sample sizes to assess the long-term durability of competency gains and the direct impact of those gains on patient care outcomes. The systematic integration of mini-CEX into undergraduate and postgraduate curricula represents a critical step toward enhancing the quality of clinical education and preparing a highly competent healthcare workforce.

Ethics

Ethics Committee Approval: As this study utilized data from previously conducted research, no additional ethical approval was required for the present analysis.

Informed Consent: This study does not involve research conducted on human participants or animals. The manuscript is based on the analysis and synthesis of findings from previously published studies.

Footnotes

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