

Original Article



Association Between Low-Stakes Formative Assessment Scores and High-Stakes Summative Examination Outcomes Among Undergraduate Pathology Students: A Cross-Sectional Study

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Examinations, Academic,
Feedback, Medical students**Abstract****Introduction:** Competency-Based Medical Education, introduced in India in 2019, emphasizes continuous assessment through formative evaluations. However, the association of formative assessments with medical students' final summative examination performance, particularly in pathology, remains underexplored. This study aimed to examine the correlation between formative assessment scores and final summative results among second-year MBBS students in pathology and explore their perceptions of formative assessments.**Methods:** A cross-sectional study was conducted among 101 second-year MBBS students. Twelve formative assessments were administered over nine months, followed by feedback on student performance. Data from formative and summative assessments were analysed using descriptive statistics and Pearson's correlation coefficient. The comparison was only between students' formative and their own summative scores, not before/after. A self-administered survey measured students' perceptions of the effectiveness of formative assessments, using a 5-point Likert scale.**Results:** The mean formative assessment score was 51.83% (Standard deviation = 10.8), and the mean summative exam score was 61% (Standard deviation = 6.5). A significant positive correlation ($r = 0.66$, $P < 0.001$) was found between formative and summative exam scores. In the perception survey, the majority of students agreed with statements indicating that formative assessments helped them identify focus areas, build confidence, and manage exam anxiety.**Conclusion:** Formative assessment scores demonstrated a strong positive correlation with summative examination outcomes among undergraduate pathology students. While students held favorable perceptions regarding the utility of formative assessments, causality cannot be inferred due to the cross-sectional, observational design. The observed association may reflect underlying student characteristics—such as baseline academic ability, consistent study habits, or intrinsic motivation—rather than a direct effect of formative assessments on performance. These findings support formative assessments as useful indicators of student progress and valuable tools for structured feedback within the CBME framework.**Introduction**

In 2019, Competency-Based Medical Education (CBME) curriculum introduced formative assessments as a part of the medical curriculum.¹Formative assessment is a continuous process that provides timely, constructive feedback to enhance student learning, helping them prepare for the final summative exam.²Pathology occupies a unique position in undergraduate medical education as a bridge between basic sciences and clinical medicine, making it particularly suitable for studying the relationship between formative assessment and academic performance.

Despite growing recognition of the importance

and potential benefits of formative assessment in medical education, research specifically addressing its implementation and effect within pathology education remains limited.³Formative assessments are theorized to support learning through multiple mechanisms, including timely feedback, retrieval practice, self-regulated learning, and spaced reinforcement of knowledge. Within programmatic assessment frameworks, repeated low-stakes assessments provide opportunities for learners to identify knowledge gaps and modify learning strategies accordingly.

Hence, the present study was designed to test the following hypotheses: (H1) formative assessment scores

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are positively correlated with summative examination scores; and (H2) students perceive formative assessments and feedback as beneficial for summative examination preparation.

Methods

Study Design and Setting

The present correlational study was conducted among second-year MBBS students in a medical college in Southern India after obtaining institutional ethical clearance, using prospectively collected formative assessment scores and summative examination outcomes, supplemented by a cross-sectional perception survey.

Participants

Of the 146 students enrolled, 101 completed all study components and were included in the analysis. Students who missed any formative assessment or did not complete the perception questionnaire were excluded. All eligible students were invited to participate to reduce selection bias, and a self-administered questionnaire was used to minimize interviewer bias.

Sample Size Calculation

The sample size was estimated based on Atwa et al.³ assuming 85% positive perception toward formative assessment. Using the formula $n = Z^2 \times p \times q / e^2$, the initial required sample was 195. After applying the finite population correction for 146 students, the minimum required sample was 84. For detecting a moderate correlation ($r = 0.3$) or a large effect size (Cohen's $d = 0.8$), approximately 85 and 50 students were needed, respectively. The final sample size of 101 students exceeded the minimum requirements for both the correlation analysis and perception survey, ensuring adequate statistical power.

Formative Assessments

A total of twelve formative assessments were conducted over nine months. A total of twelve formative assessments were conducted over nine months. Each assessment consisted of 20 multiple-choice questions (1 mark each), 10 short-answer questions (5 marks each), and 2 long-essay questions (15 marks each), with a total duration of 3 hours. All assessments were conducted under supervised examination conditions. The formative assessments were low-stakes in nature and did not contribute to the final university examination grades. Following evaluation, faculty members conducted classroom feedback sessions in which common mistakes were discussed and model answers were reviewed. These sessions were intended to help students identify areas requiring improvement and guide subsequent learning. The scores from all twelve formative assessments and the final summative examination marks of the 101 students were compiled in Microsoft Excel for analysis. Descriptive statistics were calculated as mean $\pm$ standard deviation, pass percentages were compared, and associations between formative and summative scores were assessed using Pearson's correlation

coefficient. Score distributions were assessed using the Shapiro–Wilk test. Statistical significance was set at $P < 0.05$.

Perception Questionnaire

After the final summative exam results were published, students' perceptions of formative assessments were collected using a self-administered questionnaire prepared by the authors, based on study objectives and relevant literature. The questionnaire underwent expert review by faculty members from pathology and medical education to assess content relevance and clarity prior to administration. The tool consisted of 10 items addressing students' views on the impact of formative assessments on their summative performance. Responses were recorded on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Because the survey was administered post-results, students were fully aware of their final examination performance at the time of completion, which represents a potential source of post-hoc rationalization bias. Formal pilot testing was not conducted.

Data Analysis

Reliability of the questionnaire was assessed using Cronbach's alpha and interpreted as excellent (≥ 0.90), good (0.80–0.89), acceptable (0.70–0.79), questionable (0.60–0.69), poor (0.50–0.59), and unacceptable (< 0.50).

Results

A total of 101 second-year MBBS students participated in the study. Among the study participants, 72 (71.29%) were female, and 29 (28.71%) were male. The majority of students were aged 20–25 years ($n = 89$, 88.12%) (Table 1). The mean formative assessment score was $51.83 \pm 10.8\%$, and the mean summative examination score was $61 \pm 6.5\%$ (Table 2). Eighty-seven (86.14%) students passed the formative assessments, and 100 (99.01%) students passed the summative examination (Table 3). The median,

Table 1. Demographic Characteristics of the Study Participants ($n = 101$)

Variable	Category	n (%)
Gender	Male	29 (28.71)
	Female	72 (71.29)
Age (years)	18–20	7 (6.93)
	21–23	82 (81.19)
	24–25	12 (11.88)

Table 2. Descriptive statistics of formative and summative assessments ($n = 101$)

Parameter	Mean $\pm$ SD	Minimum	Maximum
Formative Assessment Scores (%)	51.83 ± 10.8	30	80
Summative Examination Scores (%)	61 ± 6.5	51	82

Table 3. Comparison of pass percentages ($n = 101$)

Examination	Pass n (%)	Fail n (%)
Formative Assessment	87 (86.14)	14 (13.86)
Summative Examination	100 (99.01)	1 (0.99)

interquartile range, and range for formative assessment were 53.3, 43.3–60.0, and 30–80, respectively, and the median, interquartile range, and range for summative assessment were 61.3, 55.3 – 66.7, and 45.7 – 74.3, respectively.

Additional analyses demonstrated significant positive correlations between summative examination scores and formative assessments conducted during the early phase (first four assessments; $r=0.63$, $P<0.001$), middle phase (assessments five to eight; $r=0.47$, $P<0.001$), and late phase (assessments nine to twelve; $r=0.63$, $P<0.001$).

Shapiro–Wilk testing demonstrated slight deviations from normality for formative scores ($P=0.014$) and summative scores ($P=0.038$).

A positive and statistically significant correlation was found between the formative assessment scores and the summative examination results using Karl Pearson's correlation coefficient ($r=0.66$, $P<0.001$), indicating that students who performed well in the formative assessments tended to score higher in the final summative examination (Figure 1).

The internal consistency of the questionnaire was excellent (Cronbach's $\alpha=0.96$). Responses to the 10-item Likert scale are summarized in Table 4.

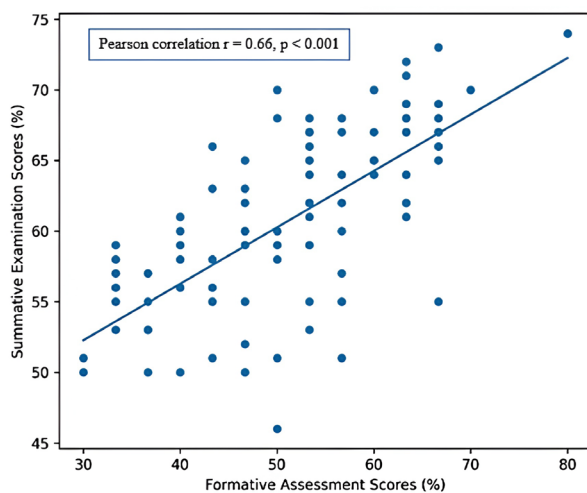


Figure 1. Correlation between formative assessment scores and summative assessment scores among second-year MBBS students ($n=101$)

Subgroup Analysis of Perceptions by Academic Performance

To address potential post-hoc rationalization bias stemming from survey timing, student perception trends were evaluated relative to summative examination performance. Students achieving passing and higher scores ($\geq 60\%$) reported generally favorable views regarding confidence building and exam preparedness. Conversely, lower-performing students ($<60\%$) demonstrated lower overall agreement across items addressing exam anxiety reduction and perceived reflective accuracy of formative assessments. This divergence highlights that post-exam survey responses were influenced by final student outcomes.

Discussion

Assessment is a key component of the CBME framework. In the classroom setting, assessments are broadly categorized into formative and summative types, each serving distinct yet complementary purposes. Formative assessment is conducted continuously throughout the learning period and is intended to provide timely, constructive feedback that supports and enhances student learning. It helps educators identify learners' strengths and areas requiring improvement, facilitating the adaptation of teaching strategies to individual learning needs. Conversely, summative assessment is typically conducted at the end of a course and is intended to assess the overall achievement of learning objectives. It provides a summary judgment of performance, often used for scoring or certification purposes. Together, formative and summative assessments create a complete assessment framework that not only measures learning outcomes but also fosters an environment helpful to ongoing learning and development.²

This study aimed to explore the relationship between formative assessment scores and final summative examination performance among second-year MBBS students in pathology and to examine students' perceptions of formative assessments and feedback within the (CBME) framework. The study revealed a statistically significant positive correlation ($r=0.66$, $P<0.001$) between formative and summative examination scores, indicating that students who performed well in formative assessments were likely

Table 4. Responses on the 5-point Likert scale ($n=101$)

Sl. No	Statement	Strongly agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly disagree n (%)
1	Helps identify focus areas for summative exams	31 (30.69)	35 (34.65)	19 (18.81)	8 (7.92)	8 (7.92)
2	Enhances confidence for summative exams	19 (18.81)	23 (22.77)	31 (30.69)	15 (14.85)	12 (11.88)
3	Encourage to study more consistently	42 (41.58)	27 (26.73)	15 (14.85)	4 (3.96)	12 (11.88)
4	Helps correct mistakes and improve performance	31 (30.69)	27 (26.73)	12 (11.88)	19 (18.81)	12 (11.88)
5	Reduces anxiety about summative examinations	19 (18.81)	15 (14.85)	38 (37.62)	15 (14.85)	12 (11.88)
6	Reflects summative exam content and difficulty	19 (18.81)	27 (26.73)	19 (18.81)	15 (14.85)	19 (18.81)
7	Motivates better exam preparation	38 (37.62)	19 (18.81)	19 (18.81)	15 (14.85)	8 (7.92)
8	Eases summative exams	35 (34.65)	12 (11.88)	27 (26.73)	12 (11.88)	15 (14.85)
9	Frequent tests positively affect performance	23 (22.77)	23 (22.77)	23 (22.77)	19 (18.81)	12 (11.88)
10	Overall, formative enhances summative performance.	35 (34.65)	27 (26.73)	19 (18.81)	12 (11.88)	8 (7.92)

to perform better in summative exams. Additionally, 86% of students passed the formative assessments, while 99% passed the summative examination, demonstrating that higher performance on low-stakes formative assessments aligned with higher scores in high-stakes summative exams.

These findings are consistent with previous literature documenting parallel trends between continuous and final evaluations. However, because this was an observational study without a control group or baseline assessment adjustments, this alignment cannot be interpreted as a causal relationship that shows a similar trend in medical education. For instance, Guthi et al.⁴ observed an improvement in students' performance in summative assessments after undergoing formative assessments, with mean scores increasing from 49.99% to 53.55%. Similarly, Donker et al.⁵ found improvements in mean scores from 67.5% to 84.3%. Bhattacharya et al.⁶ also reported an increase in both mean scores and pass percentages after the implementation of formative assessments. Rather than directly driving exam outcomes, regular formative assessments may serve as marker tools that mirror overall student engagement, baseline competency, and continuous preparation throughout the academic year.

A positive correlation between formative assessment scores and summative examination results has been reported in multiple studies, such as Bhattacharya et al.⁶ ($r=0.64$), Anjum et al.⁷ ($r=0.83$), Alexander et al.⁸ ($r=0.52$), and Chang et al.⁹ ($r=0.59$). This suggests that formative assessments serve as an effective tool for ongoing evaluation and preparation, reinforcing the importance of regular assessments in fostering academic success.

Despite the general consistency in findings, differences in results across studies could be attributed to variations in educational settings, curriculum design, assessment methods, and the timing of formative assessments. For instance, the type of formative assessments (e.g., multiple-choice questions vs. written essays) and the quality of feedback provided could influence students' engagement and learning outcomes. Additionally, variations in institutional resources, student demographics, and teaching methodologies could contribute to differences in the results observed.

Feedback is a critical component of formative assessment and serves as a bridge between assessment and learning. In this study, most students agreed that feedback from formative assessments helped them identify weaknesses, correct mistakes, and improve performance in subsequent evaluations. This aligns with the findings of Norcini and Burch¹⁰ and Velan et al.,¹¹ who emphasized that constructive feedback enhances self-directed learning and promotes deeper conceptual understanding, particularly in medical education settings. In the context of CBME, feedback plays an even more significant role since the focus is on competency development rather than mere content acquisition. Timely and personalized feedback helps learners progress through the competency milestones by addressing individual gaps and fostering self-reflection.

The perception survey in this study revealed an

overwhelmingly positive attitude toward formative assessments. A majority of students held a strongly favourable opinion of formative assessments. Most students agreed that regular formative assessments endorse more disciplined study habits, help pinpoint areas for improvement in their summative exams, facilitate error correction and performance enhancement, boost their motivation for exam preparation, alleviate stress during the summative exams, and ultimately related to enhance overall summative performance.^{12,13}

Students' perceptions were overwhelmingly positive, echoing findings from Sahoo et al.¹⁴ and Kaur et al.,¹⁵ where formative assessments improved engagement, motivation, and reduced anxiety. The study by Srivatsav et al. highlights the need for the sensitization of students and periodic feedback to be obtained from students to maximize learning. According to a study by Zulfiqar et al.,¹⁶ 64% of students agreed that it facilitates the learning process and motivates students to learn more.

Furthermore, the timing of perception data collection introduces an important caveat. As demonstrated in our subgroup comparison, higher-performing students evaluated formative assessments significantly more favorably than their lower-performing peers. This disparity suggests that students' retrospective rating of formative tools was influenced by their final academic outcome—a classic post-hoc rationalization effect. Students who achieved favorable summative marks may have naturally attributed their success to the formative assessment process, whereas struggling students viewed its utility with greater skepticism.

Although a significant positive correlation was observed, causality cannot be inferred from the present study design. It remains possible that students who performed well on formative assessments were generally higher-achieving learners who would also perform well in summative examinations irrespective of formative assessment exposure.

Differences in motivation and effort between low-stakes formative assessments and high-stakes summative examinations may also influence performance. Students may devote greater preparation and attention to summative examinations because of their academic consequences, which could partly explain the observed differences in pass percentages.

The present study did not directly evaluate how students utilized the feedback received following formative assessments. Future qualitative or mixed-methods studies may help identify the mechanisms through which feedback influences learning behaviours and academic outcomes.

This study highlights the significant role of formative assessments in medical education, particularly in the context of CBME. Regular formative assessments, when combined with timely and constructive feedback, appear to significantly enhance students' exam performance by identifying weaknesses, providing targeted improvements, and reducing anxiety around summative exams.

This study's strengths lie in its clear focus on formative

assessments and its examination of both academic performance and student perceptions. The study involved a reasonably large sample size of 101 students, which is reflective of the typical cohort in a medical college. The use of multiple types of formative assessments (e.g., multiple-choice questions, short-answer questions, and essays) also adds depth to the findings.

Limitations

This study has several limitations. First, it was conducted at a single institution, which may limit the generalizability of the findings. Second, the cross-sectional correlational design does not permit causal inference, and the observed associations may reflect unmeasured student factors such as baseline academic ability, study habits, or motivation. Third, exclusion of students with incomplete assessment data may have introduced attrition bias. Fourth, the perception questionnaire underwent expert review but was not formally pilot tested. Fifth, a major limitation of this study is that student perception data were collected after final summative examination results were announced. This timing introduces significant post-hoc rationalization bias, as students' knowledge of their final grades likely distorted their retrospective evaluation of formative feedback and assessments. This temporal limitation restricts the interpretability of the survey findings, as high perception scores may reflect satisfaction with final passing grades rather than the true objective utility of the formative assessments. Sixth, prior academic performance data were unavailable and therefore could not be controlled for in the analysis. Finally, the study did not evaluate how students used the feedback provided after formative assessments, and differences in motivation between low-stakes and high-stakes assessments may have influenced performance.

Conclusion

In this single-institution cross-sectional study, formative assessment scores were significantly and positively correlated with summative examination performance in undergraduate pathology students ($r = 0.66$, $P < 0.001$). While students perceived these evaluations and feedback sessions as beneficial for structured preparation, causality cannot be inferred from these data. The observed positive association may primarily reflect student-level factors, such as academic ability, baseline knowledge, and intrinsic study motivation, which influence performance across both assessment types. Within the CBME framework, low-stakes formative assessments serve as effective mechanisms for continuous feedback and self-directed monitoring, but controlled interventional studies are required to determine whether they exert an independent effect on summative outcomes.

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Competing Interest

The authors declare no conflict of interest.

Ethical Approval

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the MNR Institutional Ethics Committee. Written informed consent was obtained from the participants prior to their inclusion in the study.

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