Journal of Dental Sciences 21 (2026) 258–264

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jds.com

Original Article

Measurement of predictive validity of admission criteria used by public dental colleges in Pakistan. Time to reconsider

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Received 13 August 2025
Available online 26 August 2025

KEYWORDS
Admission;
Dental education;
Predictive validity;
Selection

Abstract *Background/purpose:* Dentistry education evolved from treating painful teeth to comprehensive oral care program. Oral health is an integral component of general healthcare. Like medical institutes, dental institutes have introduced admission tests as a component of selection criteria. However, various selection criteria components are not investigated for their predictive validity. This study aimed to measure the predictive value of selection criteria used in Pakistani dental colleges. This study provides recommendations for revision of weightings of admission criteria.
Materials and methods: This is a retrospective, quantitative and longitudinal cohort study. Deidentified data from a public dental college of Pakistan were analyzed. The Secondary School Certificate Examination (SSCE), Higher Secondary School Certificate Examination (HSSCE), and admission test scores were used as predictive variables, and professional examinations scores as outcome variables. Spearman's correlation coefficient and multivariate multiple regression (MMR) analyses were performed.
Results: Most data were left skewed, suggesting higher scores. The SSCE and admission test scores showed moderate positive correlation with professional examinations (*P*-values <0.001 to < 0.05). The R^2 values from 0.439 to 0.343, indicating a moderate to good amount of variance explained for each professional examination. The SSCE and admission test scores make a significant predictive model for all professional examinations.
Conclusion: The SSCE and admission test are the significant predictors of successful professional examinations. The Pakistan Medical and Dental Council (PMDC) should reconsider selection criteria weightings. A revised higher weighting for SSCE and admission test and lower weighting for HSSCE scores would bring fairness in the selection process.

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https://doi.org/10.1016/j.jds.2025.08.028

Introduction

Dental education includes the teaching and learning of strategies that help prevent, diagnose and treat oral diseases, fulfilling the dental health needs of individual patients and communities.[1] According to the recommendations presented by Gies in the 10th Carnegie Foundation report, medical education, dental education and science must be comparable and compatible with each other in terms of quality, support and outcomes.[2] Since then, dentistry education has changed its profile from simply treating painful teeth to becoming comprehensive program of knowledge and skill required by an independent, professional discipline.[3,4]

A wave of healthcare reforms is proposed and adopted for enhancing the quality of education and training to respond the opportunities and challenges inherent in developing healthcare systems.[5] In developing countries, dental education reform signifies a transformative process that strives to address the oral healthcare needs of underserved communities. This reform agenda stems from the understanding that oral health is an integral component of general healthcare. The path to achieving the aims of reform is challenging, with the insufficient supply of dental professionals being most important.[6,7]

Revised dental curriculum structures and delivery processes have resulted in the reshaping of dental education. Like medical education, dental education reform has resulted in the introduction of admission criteria to identify suitable candidates for enrolment.[8,9] The selection of appropriate candidates into dental education should be the first step in producing appropriately qualified dental professionals to serve their communities.[10]

The inclusion of admission tests in dental education needs academic investigation and evaluation. One method to do this is to measure its predictive validity power. Predictive validity is the power of a given test to anticipate the future measure of performance of a person on construct(s) of interest.[11] It measures the correlation between predictive and outcome variables. With an increase surge of applicants for dental colleges across Pakistan, this study aimed to explore how preadmission factors influenced the academic achievements of students in dental colleges.

In Pakistan, there are 9 public and 31 private dental colleges offering Bachelor of Dental Surgery (BDS) degrees. The admissions process and curriculum in these colleges are guided by the Pakistan Medical and Dental Council (PMDC), a federal accrediting body.[13–15] The PMDC mandates a centralized medical and dental college admission process that must be followed by all Pakistan medical and dental institutes. The PMDC requires candidates to have a minimum grade-B or 60 % scores in their Higher Secondary School Certificate Examination (HSSCE) to be eligible to sit an admission test. Admission tests are conducted by various institutes of the country though based on PMDC regulations, although they differ slightly, the basic criteria remain the same.[16] However, the scores achieved by candidates in the admission test make up the main component of eligibility criteria for admission into the dental college.

The admission tests assess the curricular contents prescribed by examination boards administering the Secondary School Certificate Examination (SSCE) and the HSSCE in Pakistan. The admission test consists of multiple choice questions (MCQs) for biology, physics, chemistry, English competency and critical thinking. The final merit score for admission is calculated by computing the weighted scores achieved in the SSCE, HSSCE and admission test. The PMDC has suggested a 50 % weighting for the admission test, 40 % for the HSSCE, or equivalent examination, and 10 % for the SSCE, or equivalent examination. Candidates must pass the admission test. The top ranked candidates are offered a placement in the individual dental colleges.[15]

Undergraduate dental students in Years 1 & 2 take basic science subjects. Later, in Years 3 & 4, students take clinical science subjects along with exposure to patients. Students take one year of internship after completion of their 4th year of education. The teaching methodology used by all Pakistan dental colleges includes small group teaching and learning sessions, large class lectures, laboratory sessions, community visits, out-patient and in-patient clinical teaching. Assessment tools used include MCQs, short essays, long essay questions, objective structured practical examination (OSPE), objective structured clinical examination (OSCE) and viva voce to test practical and professional competencies.[15]

The admission criteria used in Pakistan's public dental colleges is not examined comprehensively. There is a lack of methodological and empirical studies providing local contextual evidence regarding the importance of the discrete components used as admission criteria. The aim of this study was to investigate the academic importance of the prior academic achievements and admission test scores currently used by Pakistan's public dental colleges for student selection to provide evidence-based information to the decision makers.

There were three main research questions. First, to what extent did SSCE, HSSCE and admission test scores predict the future cognitive performance of candidates measured in four professional examinations. Second, which was the best model of the predictor variables. Third, was the current weighting allocated to SSCE, HSSCE and admission test scores justified. The outcomes of this study were, first, to provide scholarly information to the people involved in the selection process, to dental educationists, and potential candidates regarding the utility of the current admission tests for enrollment in Pakistan's public

dental colleges. Second, it would inform the global academic body regarding the use of admission tests conducted in the context of a developing country undergoing reforms in dental education.

Materials and methods

This was a retrospective, quantitative and longitudinal cohort study. It was conducted after approval by Human Research Ethics Committee, University of Wollongong (HE13/430). The criteria for site selection were: (i) public dental college(s) in Pakistan, (ii) have at least one batch of graduates who took an admission test, (iii) have the admission and assessment records available for analysis and (iv) have more than 50 students admitted each year. One public dental college which fulfilled the criteria agreed to share the data. This dental college admits over 85 students each year and may be considered as a representative of public dental collages of Pakistan.

The deidentified data of one batch of 85 students were shared. The preadmission data considered predictor variables included SSCE, HSSCE, and admission test scores. The post-admission assessment data considered as outcome variables included four end-of-year professional examination scores. The data were analyzed using Statistical Package for Social Sciences (SPSS) IBM SPSS Statistics 29 (IBM Corporation, Armonk, NY, USA). During data cleaning, cases with missing values were removed. Finally, 55 cases were selected for analysis. Initially, descriptive analysis was carried out to understand the characteristics of the data. Spearman's correlation coefficient and multivariate multiple regression (MMR) analyses were performed. The correlation analyses were conducted to analyze the associations between different predictors and outcome variables. Later, regression analyses were performed to identify and measure the effect of various models of predictor variables on outcome variables. Studies, investigating the relationship between various admission tests, school assessments, and assessments during and after medical education, commonly used correlation coefficient and MMR analyses for making predictions.[17–23] MMR analysis was conducted to examine how SSCE, HSSCE and admission test predict scores on four professional examinations. To check if the data met the assumption of MMR analysis, Box's Test of Equality of Covariance Matrices and Levene's Tests were conducted. The Box's Test of equality of covariance matrices did not show statistically significant result (F (10, 3924.25) = 1.36, P-value = 0.194). It concluded that the assumption of homogeneity of covariance matrices was met. Levene's Test also showed non-significant results for all dependent variables (P-value >0.05), supporting the assumption of homogeneity of error variances. Hence, the MMR analysis was appropriate to conduct without concern regarding multicollinearity.

Results

Table 1 shows mean scores, standard deviation (SD) and distribution of pre-admission and professional examination data. Most of the data showed a left sided skewness though the Kolmogorov–Smirnov and Shapiro–Wilk tests did not show statistically significant evidence of non-normality.

Table 2 shows the Spearman's correlation coefficient of various predictor and outcome variables. The data suggests that the admission test has the most substantial monotonic relationship with student performance in the professional examinations, followed by SSCE, while HSSCE does not appear to have a significant monotonic relationship.

Table 3 summarises MMR output, focusing on the multivariate tests, and shows the overall effects of predictors on the combination of the four professional examinations. It showed that the admission test had a statistically significant role in predicting professional examination scores. The SSCE had a borderline significance at P-value = 0.061. It would have had a relatively moderate effect size, if it had been significant in predicting the combination of the four professional examinations scores at the conventional P-value <0.05 level. The HSSCE did not have a statistically significant role in prediction.

Table 4 shows the unique (univariate) contributions of each predictor to each professional examination score. The corrected model for all four professional examinations was statistically significant (P-value <0.001). This indicates that the set of predictors significantly predicts each

Table 1 Descriptive statistics and normality tests of various predictor and outcome variables.

	N (55)		Skewness		Kolmogorov–Smirnov (df = 55)		Shapiro–Wilk (df = 55)	
	Mean	SD	Statistics	Statistic	Statistic	Sig.	Statistic	Sig.
SSCE	7.923	0.651	−0.586	0.322	0.103	0.200	0.967	0.129
HSSCE	32.582	2.017	−0.381	0.322	0.106	0.191	0.969	0.16
Admission test	21.698	5.279	0.032	0.322	0.092	0.200	0.989	0.902
1st Professional examination	967.273	104.173	0.073	0.322	0.063	0.200	0.991	0.955
2nd Professional examination	871.855	78.863	−0.423	0.322	0.062	0.200	0.978	0.397
3rd Professional examination	1010.2	72.346	−0.447	0.322	0.047	0.200	0.981	0.529
4th Professional examination	1013.636	101.31	−1.358	0.322	0.102	0.200	0.918	0.001

Abbreviations: df, Degrees of freedom, HSSCE, Higher secondary school certificate examination. N, number., SSCE, Secondary school certificate examination. SD, standard deviation. SE, standard error.

Table 2 Spearman's rho correlation coefficient of various predictor and outcome variables.

Predictor variables	Outcome variables	Spearman's rho	Significance (2-tailed)	95 % Confidence Intervals (2-tailed)	
				Lower	Upper
SSCE	1st Professional examination	0.292	0.031*	0.021	0.523
	2nd Professional examination	0.38	0.004**	0.12	0.592
	3rd Professional examination	0.374	0.005**	0.113	0.587
	4th Professional examination	0.375	0.005**	0.114	0.588
HSSCE	1st Professional examination	0.18	0.19	−0.098	0.431
	2nd Professional examination	0.228	0.095	−0.048	0.471
	3rd Professional examination	0.095	0.488	−0.182	0.359
	4th Professional examination	0.174	0.204	−0.104	0.427
Admission test	1st Professional examination	0.551	0.001**	0.327	0.716
	2nd Professional examination	0.522	0.001**	0.291	0.696
	3rd Professional examination	0.464	0.001**	0.219	0.654
	4th Professional examination	0.446	0.001**	0.197	0.641

*Correlation is significant at the *P*-value <0.05 level (2-tailed).
**Correlation is significant at the *P*-value <0.01 level (2-tailed).
Abbreviations: HSSCE, Higher secondary school certificate examination.
SSCE, Secondary school certificate examination.

Table 3 Multivariate Regression Results of individual predictors on overall Professional Examination Scores.

Source	Multivariate Test Statistics-Wilk's Lambda Value	F	Hypothesis df	Error df	*P*-value	ηp^2
SSCE	0.829	2.431	4.000	47.000	0.061	0.171
HSSCE	0.940	0.744	4.000	47.000	0.567	0.060
Admission test	0.639	6.636	4.000	47.000	<0.001*	0.361

** *P*-value <0.01 was considered significant.
Abbreviations: df, Degrees of freedom. F, F-statistics. HSSCE, Higher secondary school certificate examination. ηp^2, Partial eta squared. SSCE, Secondary school certificate examination.

Table 4 Predictor effect of individual predictor variable on different professional examination scores.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	*P*-value	ηp^2
SSCE	1st Professional examination	21291.22	1	21291.22	3.24	0.078	0.06
	2nd Professional examination	36927.37	1	36927.37	9.62	0.003*	0.16
	3rd Professional examination	27456.00	1	27456.00	8.38	0.006*	0.14
	4th Professional examination	50241.35	1	50241.35	6.90	0.011*	0.12
HSSCE	1st Professional examination	10049.22	1	10049.22	1.53	0.222	0.03
	2nd Professional examination	3054.98	1	3054.98	0.80	0.377	0.02
	3rd Professional Examination	74.23	1	74.23	0.02	0.881	0.00
	4th Professional examination	122.51	1	122.51	0.02	0.897	0.00
Admission test	1st Professional examination	175063.78	1	175063.78	26.62	<0.001**	0.35
	2nd Professional Examination	64969.01	1	64969.01	16.93	<0.001**	0.25
	3rd Professional examination	53430.05	1	53430.05	16.30	<0.001**	0.25
	4th Professional examination	76462.89	1	76462.89	10.50	0.00**	0.17

**P*-value <0.05 was considered significant.
***P*-value <0.01 was considered significant.
Abbreviations: df, Degrees of freedom. F, F-statistics. HSSCE, Higher secondary school certificate examination. ηp^2, Partial eta squared. SSCE, Secondary school certificate examination.

examination score individually. Univariate effects and coefficients presented in Table 4 revealed that the admission test was a highly significant unique predictor for all professional examinations. The SSCE score was another significant unique predictor for the 2nd, 3rd and 4th professional examinations, with positive coefficients shown. The HSSCE did not show statistically significant unique effects on any professional examination scores.

Table 5 shows the actual models, regression coefficients (B) and their significance for each predictor for each dependent variable. The R^2 values ranged from 0.439 (1st Professional examination) to 0.343 (4th Professional examination). The R^2 values reduced from the 1st to 4th professional examinations, indicating a substantial to moderate amount of variance explained by the predictor models for each subsequent professional examination. The admission test had a highly significant predictive effect on all professional examinations individually. The unstandardized coefficients (B) indicate that the higher admission test scores are consistently associated with higher professional examination scores. In addition, the SSCE has a significant predictor effect on all professional examinations except the 1st professional examination. In contrast, the HSSCE has no significant predictive role on any professional examination. The overall model of admission test and SSCE scores shows a substantial to moderate amount of variance in each professional examination.

Discussion

This study investigated the predictive validity of admission variables, i.e., SSCE, HSSCE and admission test scores for Pakistan's dental colleges. The author investigated the relationship of these variables across the four years of undergraduate dental education in a public dental college in Pakistan. This is the first retrospective longitudinal cohort study of its kind in a local context. This study showed that different admission criteria had different significance in predicting the future academic achievement of undergraduate students in professional dental examinations. This study found that the admission test and the SSCE scores were the significant predictors while the HSSCE scores were not.

Studies have shown high school grades and aptitude test scores, age and marital status have a significant influence on future assessment scores.[12,24] The findings of this study contrast with the conclusions drawn by AlMalki et al.[12] They reported that high school grades taken separately have a significant role in academic success in dental education in Saudi Arabia. Similarly, Al-Asmar et al. reported a weak but significant positive correlation (0.3) between high school grade point average (GPA) and graduating academic achievement for Syrian dental students (*P*-value $\leq$0.05).[24] This difference could be due to different school syllabi followed in different countries. In a study conducted in Pakistan, HSSCE scores were found to have a weak positive correlation with the 1st professional examination in dental college.[16] The current study found no significant role of high school scores, whether these are taken as a separate component or combined with other variables.

Furthermore, this study found that the admission test score is a strong predictor of future dental academic achievement. Similar admission tests, e.g., the Biomedical Admission Test, show similar correlations.[25] Such a correlation is best observed in the preclinical years only, not beyond.[26] The current study supported this trend in prediction. The academic performance in preclinical years was better correlated with the admission test and the SSCE scores than in the later clinical years. The scores in the later years showed a left shift, which means higher scores achieved by students. It suggests that the SSCE and admission test scores predict the outcome variable at lower scores in preclinical years better than later years. The reason for this decline could be due to the academic influence dental education itself. This might have prepared them for their clinical years' studies. Hence, the influence of difference between high and low achievement in pre-admission scores fades out in clinical years.

The PMDC suggested SSCE, HSSCE and admission test scores should be given a weighting of 10 %, 40 % and 50 %, respectively, in calculating a final merit score for admission. This study found that the SSCE score is a better predictor than the HSSCE score. This means the current weightings of various admission criteria need to be revisited. The SSCE scores should be reconsidered with higher weighting compared to the HSSCE scores. This revision of

Table 5 Regression coefficients (B) and their significance for each predictor.

Dependent Variable	Predictor model	B	SE	t	*P*-value	ηp^2	R^2
1st Professional examination	Admission test	10.959	2.124	5.159	<0.001*	0.347	0.439
	SSCE	36.363	20.210	1.799	0.078	0.061	
2nd Professional examination	Admission test	6.676	1.623	4.114	<0.001*	0.253	0.429
	SSCE	47.889	15.438	3.102	0.003*	0.161	
3rd Professional examination	Admission test	6.054	1.499	4.038	<0.001*	0.246	0.420
	SSCE	41.293	14.266	2.894	0.006*	0.144	
4th Professional examination	Admission test	7.243	2.235	3.241	0.002*	0.174	0.343
	SSCE	55.859	21.265	2.627	0.011*	0.121	

**P*- value $<$ 0.05 was considered significant.
***P*- value $<$ 0.01 was considered significant.
Abbreviations: B, (Beta) regression coefficient (unstandardized). ηp^2, Partial eta squared. HSSCE, Higher secondary school certificate examination. R^2, R-squared (coefficient of determination). SE, standard error. SSCE, Secondary school certificate examination. t, t-statistic.

weighting would design the admission criteria appropriate in the selection process for dental colleges. An admission model based on the combination of an admission test and SSCE scores showed to have a significant value in predicting the higher professional examination scores. In the selection process a higher weighting of 40 % allocated to HSSCE scores may put potentially appropriate candidates at an unfair disadvantage.

The strength of this study results from it using detailed longitudinal retrospective data for analysis. It provided findings which will help fill the knowledge gap in contextual predictive validity studies. It investigated the academic achievements at one Pakistan public dental college of all registered students before admission and during the course of their undergraduate dental education. It highlighted the significant problem in assigning appropriate weighing of various admission variables. The outcome of this study provided an evidence-based recommendation to the accrediting bodies to revisit the weighting of the admission criteria used to select the most suitable candidates. By identifying suitable candidates who are more likely to be successful in their studies, it may help address the shortage of dental health practitioners in Pakistan.

This study has limitations. The first is selecting a single site with one batch of students only. This may limit the generalizability of findings to other Pakistani dental colleges. Future studies including other dental colleges of Pakistan would help address this weakness. Second, a limitation would emerge from the comparison to other predictive validity studies. Those studies analyzed students' scores achieved in schools following different incomparable syllabi.

In conclusion, dentistry education curriculum reform in developing countries like Pakistan represents a pivotal pathway toward improving oral healthcare access, quality, and equity. The findings of this study should be looked at through the predictive validity and fairness of the admission process lens. This study found that in Pakistan the SSCE and admission test scores together make a better predictive model for selection than the inclusion of HSSCE scores into equation. A revised weighting of admission criteria would bring fairness in the selection process.

Declaration of competing interest

The author has no conflicts of interest relevant to this article.

Acknowledgments

No funding was used for this research article.

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