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ABSTRACT

Acceptable performance on the Medical College Admissions Test (MCAT) is necessary for acceptance into medical school; therefore, students planning a career in medicine and their advisors would benefit by having information useful in predicting performance on this examination. The present study examined the validity of the ACT Assessment as such a predictor, using as subjects 197 undergraduate students at a large midwestern university who applied to the medical school during a five year period. The results indicated that the ACT composite score was strongly related to MCAT performance, although the predictability was enhanced by inclusion of information on the student's grade point average in science subjects: multiple R's ranged from .57 for predicting MCAT reading to .62 for biology. Used appropriately, these results will be beneficial to undergraduate students, pre-medical advisors, and others in determining the need for remedial coursework and deciding when to take the MCAT examination. (Author/PN)

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# Predicting MCAT Examination Scores

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Abstract

Acceptable performance on the MCAT examination is necessary for acceptance into medical school; therefore, students planning a career in medicine and their advisors would benefit by having information useful in predicting performance on this examination. The present study examined the validity of the ACT examination as such a predictor, using as subjects 197 undergraduate students at a large midwestern University who applied to the medical school during a five year period. The results indicated that the ACT composite score was strongly related to MCAT performance, although the predictability was enhanced by inclusion of information on the student's grade point average in science subjects: multiple R's ranged from .57 for predicting MCAT reading to .62 for biology. Used appropriately, these results will be beneficial to undergraduate students, pre-medical advisors and others in determining the need for remedial coursework and deciding when to take the MCAT examination.

Professional educational activities include counselling and advising functions as well as teaching. Advice on strategies to gain admission to professional and graduate schools is an important component of the counselling process. Admission to most U.S. and Canadian medical schools depends upon three factors: undergraduate grade point average, scores on the MCAT examination, and other dimensions such as interview performance or other evidence of interpersonal skills and behavior-related factors (1-5). Pre-medical advisors and others who counsel undergraduate students regarding careers in medicine provide guidance on coursework, when to take the MCAT examination, schools to apply to, and general strategies for gaining admission. From the personal experience of one of the authors (DRD), pre-medical advisors initially use grades, especially those in science-related subjects, as indicators of success. Once students have taken the MCAT examination, advisors may recommend application to medical school or, in the case of low scores, may suggest further coursework or special study followed by another try at the MCAT. (In extreme cases, of course, they often counsel alternate career choices.) Even though the MCAT examination is not an educational outcome in itself, its utility as an index for medical school selection makes it desirable for students to score well. Therefore, undergraduate students aspiring to a career in medicine and their advisors would profit by being able to "predict" how well they will do on the MCAT examination. It may be that coursework of a remedial nature can be undertaken prior to the expense of taking the MCAT examination.

Natural candidates for such predictors are the standardized examinations students take for admission to college itself, such as the SAT and ACT.

There appears to have been little research on the applicability of the SAT or ACT examinations to predict measures other than undergraduate performance of students. The SAT was evaluated for its potential as an indicator of performance in one U.S. medical school over a ten year period (6), and it was found that four subgroups, based on each of the verbal and mathematics subtests scores, were different with respect to their subsequent performance on some criteria of success in medical school. In a discussion of the validity of the SAT and the MCAT, the authors noted correlations (not corrected for restriction of range) of .55 between SAT verbal and MCAT verbal and of .37 between SAT mathematics and MCAT science.

The predictive validity of the ACT for success in nursing school was examined in two studies. One study examined data over a ten year period to determine whether the ACT subtests have incremental validity in predicting success in the nursing curriculum itself (7). Another study examined the capability of the ACT score and other measures to predict performance on the State Board Examination in Nursing (8). The stability of prediction, independent of undergraduate major, was examined using a national sample of colleges participating in the ACT testing program between 1972 and 1977 (9). Although the correlations across the four study years were stable, the analysis was based upon high school grade point average as well as ACT scores, and no results were presented for these latter scores alone.

A review of several past volumes of the primary journals devoted to research in medical education and computerized literature searches on MEDLINE and ERIC failed to disclose additional sources. Therefore, the present study was designed to evaluate the efficacy of the ACT as a predictor of performance on the MCAT examination. Since students and pre-medical advisors also have information on the undergraduate grade point averages--both in science subjects and in nonscience subjects--the incremental validity of this information was also evaluated. It was expected that the ACT English and mathematics subtests would correlate highest with their MCAT counterparts and the ACT natural science with MCAT biology and science problems. The grade point averages were expected to add significantly to all the prediction equations.

## Method

Subjects were students attending Southern Illinois University (SIU) at both Carbondale and Edwardsville campuses who applied for admission to the SIU School of Medicine during the years 1978 through 1982. Only those applicants who had been students at SIU and had ACT scores on file with the University were included. Computer tapes provided the School of Medicine by the Association of American Medical Colleges were the source for data elements from the AMCAS biocard. In addition to biographic information, these elements included the MCAT subtest scores and cumulative undergraduate grade point average (GPA) in nonscience subjects (AO) and in science subjects (BCPM) at the time of application. All MCAT scores were based on the new examination, and if taken more than one time, the scores from the first administration were used for analysis.

The data were analyzed using the Statistical Package for Social Sciences (SPSSX). In addition to basic descriptive statistics, correlation and regression analyses on each of the six MCAT scores were performed. If two independent variables were highly correlated, one was eliminated to reduce effect· ꟳ multicollinearity. ACT subtest scores with regression coefficients significant at .10 were retained in the equations. In the incremental analysis, a variable was retained only if its addition was significant at $p<.05$. The analysis was then repeated using the ACT composite score in place of the four subtest scores. The sample was then randomly divided into two parts and the analytic procedures repeated on each subsample for a double cross-validation analysis.

## Results

The search of the AMCAS computer tapes for the medical school applicant years from 1978 through 1982 resulted in 364 students who had been enrolled at Southern Illinois University--Carbondale or Edwardsville. University records had ACT examination scores on file for 197 of these students, indicating that the remaining 167 applicants had matriculated as undergraduate transfers or as graduate students. Of the 197 students for whom complete data were available, 19.8% of the applicants were female. Mean MCAT scores ranged from 8 to 9, with standard deviations of approximately 2. The mean nonscience (AO) GPA was 3.56; the mean science (BCPM) GPA was 3.31; both had a standard deviation less than 0.5. Mean ACT scores ranged from 21.5 in English to 27.7 in natural science; standard deviations were approximately 4. This sample included 54 applicants who were subsequently admitted to the medical school at SIU.

The correlations among all continuous variables are given in Table 1. The two GPA's were correlated at .72. The ACT composite score was highly correlated (.73 to .82) with all ACT subtest scores. The correlations between the ACT and MCAT subtests were generally in the .30's and .40's. As hypothesized, the MCAT quantitative subtest was most highly correlated with ACT mathematics. The MCAT reading and science problems, however, were correlated most highly with ACT social science scores, which also correlated as highly with MCAT biology as did ACT natural science. Correlations between the composite ACT and MCAT scores were higher, however, ranging from .43 to .55. All but three interset correlations were significant at p=.001.

The regression equations based upon individual ACT scores using the total sample produced multiple correlation coefficients ranging from .480 for MCAT chemistry to .561 for MCAT reading (Table 2A). Because of the high correlation between the GPA's, only the BCPM grade point average was used in the incremental regression analyses. The results indicated a significant improvement over the prediction based on ACT scores alone in all scores; the multiple R's ranged from a low of .584 for physics to a high of .623 for biology. The addition of sex produced small but significant increases (p<.05) for predicting all subtests except biology and reading, with males predicted to score higher. Regression equations are given in Table 3.

Because of the relatively high correlations between the composite ACT its subtests, the analyses were duplicated regressing on ACT composite in place of the four ACT subtest scores (Table 2B). Comparison of correlations based on dependent samples (10) indicated no significant differences (p>.05) between these results and those based upon using ACT subtests. The addition of the BCPM GPA resulted in regression results similar to those achieved using individual subtest scores, and the addition of sex increased all predictions except MCAT reading (Table 3).

The cross-validation analysis generally resulted in similar-sized multiple correlations in the two subsamples (Table 2). The apparent exception was the prediction of the MCAT physics subtest; however, the differences were not significant ($p>.05$) after the addition of the BCPM GPA to the regression equation. There was some variation between the two subsamples in the magnitude of the regression coefficients, given in detail for the regression on composite score in Table 4, and also indicated by the inconsistent results for the addition of the sex variable to the regression on ACT component scores (Table 2A). None of the differences in regression coefficients was significant at $p<.05$, however. The cross-validation multiple correlations obtained by applying the regression equation from one subsample to the other (Table 4) show an amount of shrinkage generally within the expected ranges predicted by the Wherry or Olkin Pratt formulae (11). Only in the prediction of the quantitative subtest did the observed values of the cross-validation R depart from the predicted value based on the above formulae by more than .05. Therefore, the regression equations based upon the entire sample are justified and can be used on similar samples with some confidence in their predictions.

## Discussion and Conclusions

The present study has demonstrated the usefulness of both the ACT component scores and composite score in predicting the MCAT subtest scores. The prediction is significantly enhanced with the addition of the nonscience (BCPM) grade point average to the regression on all MCAT subtests and with the sex of the students on all except reading and quantitative. These findings should be very useful to students and pre-medical advisors at undergraduate schools that have ACT and MCAT score distribution similar to those observed in the present study; i.e., mean ACT composite of 25 with a standard deviation of 4 and slightly negatively skewed, and mean MCAT scores of 8 to 9 with standard deviations of 2 and slight negative skewness. These results may not generalize to highly competitive undergraduate environments in which the scores are significantly different or the range of scores is more restricted. The present study should be replicated in university settings in which the selection criteria produce a student population more homogeneous than that at Southern Illinois University.

With the above caveat in mind, pre-medical advisors may find the prediction equations produced in this study of use with their advisees and pre-med clubs. Many medical schools utilize a cut-off score, especially on the science problems subtest of the MCAT. For example, SIU uses the sixtieth centile (a score of 8) as a recommended selection factor. In order to obtain a predicted science problems score of 8 with a science grade point average of 3.5, a student would require an ACT composite score of 20 if a male and 25 if a female or (found by substituting the appropriate values in the equation in Table 3). This calculation represents the ACT score needed to predict a mean science problems score of 8, and a pre-medical advisor might suggest the need for a higher GPA with an ACT composite in the range of 20 to 25 to increase the likelihood of a score of 8. Alternately, it may be appropriate for the student to take additional science coursework or a review course designed to increase performance on the MCAT.

Of course, many factors affect how any given student will perform on a national, standardized examination, such as the MCAT. That past performance on the ACT examination is indicative of future performance on the MCAT is not terribly surprising. The present study, however, has attempted to formalize this relationship in a way that is useful to students who wish to apply to medical school and to the people who advise and counsel them. It is hoped that these students, their parents, and advisors will find the relationships derived in this study a useful addition to the other information typically used in career planning and counselling.

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Table 1: Correlations Among All Variables*

| | ACT | | | | | GPA | | MCAT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Eng | Math | Soc Sci | Nat Sci | Comp | AO | BCPM | Bio | Chem | Phys | Sci Prob | Read | Quant |
| **ACT** | | | | | | | | | | | | | |
| English | | .41 | .52 | .46 | .73 | .37 | .30 | .19 | .20 | .15 | .25 | .39 | .38 |
| Mathematics | | | .38 | .47 | .73 | .37 | .40 | .30 | .32 | .39 | .35 | .29 | .45 |
| Social Science | | | | .60 | .82 | .32 | .42 | .42 | .43 | .32 | .46 | .53 | .40 |
| Natural Science | | | | | .81 | .42 | .45 | .42 | .40 | .42 | .44 | .47 | .43 |
| Composite | | | | | | .47 | .51 | .44 | .44 | .43 | .50 | .55 | .55 |
| **GPA** | | | | | | | | | | | | | |
| All other | | | | | | | .72 | .38 | .30 | .25 | .33 | .40 | .38 |
| BCPM | | | | | | | | .58 | .55 | .51 | .53 | .41 | .45 |
| **MCAT** | | | | | | | | | | | | | |
| Biology | | | | | | | | | .61 | .59 | .74 | .42 | .50 |
| Chemistry | | | | | | | | | | .70 | .79 | .39 | .49 |
| Physics | | | | | | | | | | | .76 | .23 | .49 |
| Science Problems | | | | | | | | | | | | .40 | .56 |
| Reading | | | | | | | | | | | | | .43 |
| Quantitative | | | | | | | | | | | | | |

*Two-tailed critical values require $r \geq .14$ at $p = .05$; $r \geq .19$ at $p = .01$; $r \geq .24$ at $p = .001$.

Table 2: Multiple Correlation Coefficients for Cross Validation Samples
A. Using ACT Subtest Scores

| MCAT Subtest Predicted | ACT's only | | | Adding BCPM | | | Adding Sex | | |
|---|---|---|---|---|---|---|---|---|---|
| | Samp 1 | Samp 2 | Total | Samp 1 | Samp 2 | Total | Samp 1 | Samp 2 | Total |
| Biology | .497 | .482 | .487 | .599 | .670 | .623 | | .691 | |
| Chemistry | .527 | .45[illegible] | .490 | .629 | .597 | .606 | .658 | | .630 |
| Physics | .596 | .346 | .496 | .648 | .484 | .584 | | .534 | .613 |
| Sci Prob | .572 | .467 | .527 | .636 | .576 | .611 | | .612 | .632 |
| Reading | .578 | .577 | .570 | .605 | .598 | .59[illegible] | | | |
| Quant | .589 | .559 | .564 | .620 | .590 | .596 | .654 | | .610 |

B. Using ACT Composite Score

| MCAT Subtest Predicted | ACT's only | | | Adding BCPM | | | Adding Sex | | |
|---|---|---|---|---|---|---|---|---|---|
| | Samp 1 | Samp 2 | Total | Samp 1 | Samp 2 | Total | Samp 1 | Samp 2 | Total |
| Biology | .463 | .380 | .437 | .576 | .627 | .599 | | .662 | .615 |
| Chemistry | .492 | .383 | .443 | .603 | .562 | .581 | .636 | .601 | .616 |
| Physics | .552 | .207 | .429 | .620 | .415 | .544 | .649 | .492 | .592 |
| Sci Prob | .564 | .384 | .499 | .628 | .532 | .595 | .645 | .586 | .625 |
| Reading | .561 | .547 | .553 | .577 | .576 | .574 | | | |
| Quant | .556 | .549 | .554 | .594 | .583 | .587 | .624 | | .602 |

Note: Blanks indicate no significant increase in R at $p<.05$.

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Table 3: Regression Equations for Entire Sample

| MCAT Subtest Predicted | Using ACT Subtest scores | | | | | | | Using ACT Composite Score | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Eng | Math | SSci | NSci | BCPM | Sex | Const | Compo | BCPM | Sex | Const |
| Biology | -.07 | * | .07 | .06 | 1.69 | | 1.16 | .10 | 1.77 | .63 | .11 |
| Chemistry | * | * | .08 | * | 1.66 | .87 | -.29 | .12 | 1.70 | .98 | -.85 |
| Physics | * | .07 | * | .09 | 1.54 | 1.00 | -.98 | .13 | 1.62 | 1.20 | -1.24 |
| Sci Prob | * | * | .09 | .06 | 1.59 | .91 | -1.55 | .18 | 1.62 | 1.02 | -2.17 |
| Reading | * | * | .11 | .07 | .68 | | .46 | .25 | .65 | | .07 |
| Quant | .08 | .10 | * | * | .88 | .61 | -1.70 | .24 | .88 | .62 | -1.45 |

*Regression coefficient not significant (p=.10).

Blanks indicate no significant increase in R at p<.05.

Table 4: Regression Equations Using ACT Composite Score

| MCAT Subtest Predicted | Sample | Composite | BCPM | Sex | Constant | R | Cross-Val. R(1) |
|---|---|---|---|---|---|---|---|
| Biol | n=197 | .10 | 1.77 | .63 | .11 | .615 | |
| | n=98 | .09 | 1.52 | | 1.54 | .627 | .592 |
| | n=99 | .14 | 2.12 | .95 | -2.12 | .662 | .610 |
| Chem | n=197 | .12 | 1.70 | .98 | -.85 | .616 | |
| | n=98 | .09 | 1.76 | 1.10 | -.41 | .636 | .632 |
| | n=99 | .16 | 1.72 | .93 | -1.95 | .601 | .573 |
| Phys | n=197 | .13 | 1.62 | 1.20 | -1.24 | .592 | |
| | n=98 | .17 | 1.58 | 1.14 | -2.15 | .649 | .647 |
| | n=99 | .07 | 1.53 | 1.16 | .92 | .492 | .476 |
| Sci Prob | n=197 | .18 | 1.62 | 1.02 | -2.17 | .625 | |
| | n=98 | .19 | 1.56 | .88 | -2.04 | .645 | .637 |
| | n=99 | .18 | 1.68 | 1.16 | -2.31 | .586 | .533 |
| Reading | n=197 | .25 | .65 | | .07 | .574 | |
| | n=98 | .22 | .62 | | .87 | .577 | .509 |
| | n=99 | .29 | .78 | | -1.52 | .576 | .511 |
| Quant | n=197 | .24 | .88 | .62 | -1.45 | .602 | |
| | n=98 | .19 | 1.04 | 1.02 | -.95 | .624 | .506+ |
| | n=99 | .29 | .82 | | -1.99 | .587 | .450+ |

(1) The first correlation is between the actual and predicted subtest scores in the first sample using the second sample regression equation; the second correlation is between the actual and predicted subtest scores in thes second sample using the first sample regression equation.

Blanks indicate no significant increase in R at $p<.05$.

+Cross-validated R varies from estimated by more than .05.