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ABSTRACT

Relationships among variables that may predict medical school graduates who will be licensed, will practice primary care medicine, and will select Ohio and southwestern Ohio as the location of their practice were evaluated with the 1980 initial graduating class of the Wright State University School of Medicine, Ohio. The following statistical analyses were performed: (1) correlations among 24 quantitative variables; (2) multiple regression with National Boards Average Part I and Part II as dependent variables and nine independent variables; (3) contingency tables relating location of residency and type of practice with hometown and age at matriculation; and (4) logistic multiple regression with location of residency and type of practice as dependent variables and eight independent variables. Predictor variables included undergraduate grade point average (GPA), the four subtests of the Medical College Admission Test, age at matriculation, Biennium 1 GPA, clinical clerkship GPA, cumulative GPA, and 15 National Board scores. It is suggested that the results are valuable to the program evaluation and development efforts of a new medical school. The findings are pertinent for one class at one time period. The study is the first in a series that will examine various classes longitudinally and cross-validate findings from class to class and year to year. (SW)

The Prediction of National Board Performance, Medical Specialty, and Location of Residency for a Charter Class

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Abstract

For a charter medical school class statistical analyses were performed to investigate relationships among variables and the prediction of three program goals--ability to be licensed, practice of primary care medicine, and location of practice. Statistical analyses performed were correlation, multiple regression, contingency tables, and logistic multiple regression. Predictor variables included undergraduate GPA, Medical College Admission Test scores, medical school GPAs, National Board scores, age at matriculation, and hometown. The results are valuable to the program evaluation and development efforts of a young medical school. The study is the first in a series of longitudinal and cross-validation investigations.

Introduction

An educational program must examine continually how well it is achieving its goals. From its inception the Wright State University School of Medicine (WSUSOM) has recognized the need for program evaluation. Among other goals, WSUSOM endeavors to generate graduates who (1) are licensable, (2) will practice primary care medicine, and (3) will practice in Ohio and more specifically southwestern Ohio. In June 1980 the Wright State University School of Medicine graduated its first class. The thirty-one graduates began their residency training in July 1980. Descriptive data related to these three goals for the charter class (Class of 1980) have been favorable--commendable performance on National Board examinations, two-thirds of the graduates in primary care specialties, three-quarters of the graduates choosing Ohio residencies, and nearly sixty percent choosing southwestern Ohio residencies. This paper examines relationships and predictors with regard to these three goals. The study is the first in a series which will (1) examine various classes longitudinally and (2) cross-validate findings from class to class and year to year. Through such a collection of studies compiled over the years, reliable and valid conclusions can be drawn.

Theoretical Framework

The role and value of the examinations of the National Board of Medical Examiners have been amply documented (Gough and Hall, 1975; Hubbard, 1978; Samph and Templeton, 1979). The results from the current study will be discussed within this framework. Studies investigating variables which might be related to specialty preference and practice location have proliferated as the government and the medical profession have become keenly interested in the issue of physician maldistribution. Researchers (e.g., Cullison, et al., 1976; McGrath and Zimet, 1977; Yancik, 1977; Erdmann et al., 1978; Eagleson and Tobolic, 1978; Asken and Strock, 1978; Parker and Sorensen, 1978; Evashwick et al., 1979; Haug et al., 1980; Stewart et al., 1980) have examined a variety of factors including age of decision to study medicine, size of hometown, preference for patient contact, exposure to primary care role models, decentralization of clinical education, gender, curricular exposure to primary care practice, influence of spouse and family, availability of clinical support and professional contact, and site of medical training.

Methodology

Twenty-four quantitative variables were of interest--six pre-WSUSOM variables (Undergraduate Grade Point Average, the four subtests of the Medical College Admission Test, and age at matriculation), three WSUSOM variables (Biennium 1 GPA, Year 3--clinical clerkships--GPA, and Cumulative GPA), and fifteen National Board scores. Table 1 lists these variables and reports means and standard deviations.

A correlation matrix was constructed for the 24 quantitative variables (Table 2). Two multiple regression analyses were performed (Table 3). First, the nine pre-WSUSOM and WSUSOM variables were used to find which could be used as predictors of National Boards Average Part I. Secondly, the same nine independent variables were used to predict National Boards Average Part II.

Tables 4 through 11 (contingency tables) classify data into categorical variables and relate location of residency and type of practice to hometown and age at matriculation. A graduate's hometown was classified as urban or nonurban using the American Medical Association's widely accepted classification system outlined in Physician Distribution and Medical Licensure in the United States, 1976 (Goodman, 1977).*

Four logistic multiple regression analyses were performed (Table 12). Location of residency and type of practice were used as dependent variables; eight quantitative measures were used as independent variables.

County Size*	County Class
Nonurban:	
Nonmetropolitan with less than 10,000 inhabitants	1
Nonmetropolitan with 10,000 to 24,999 inhabitants	2
Nonmetropolitan with 25,000 to 49,999 inhabitants	3
Nonmetropolitan with 50,000 or more inhabitants	4
Urban:	
Potential metropolitan	5
Metropolitan with 50,000 to 499,999 inhabitants	6
Metropolitan with 500,000 to 999,999 inhabitants	7
Metropolitan with 1,000,000 to 4,999,999 inhabitants	8
Metropolitan with 5,000,000 or more inhabitants	9

Results[1]

The correlation matrix (Table 2) contains relationships of interest other than correlations involving National Board scores. For example:

1) Undergraduate GPA was significantly correlated with only one Medical College Admission Test[2] score (MCAT Science at .37) and that correlation is a modest one. Thus, the two primary academic criteria used in admission decisions--undergraduate GPA and MCAT--apparently measured different aspects of academic performance.
2) The four MCAT scores were virtually uncorrelated except for the correlation of MCAT Verbal and MCAT General Information at .74. This suggests that these two MCAT scores were measuring a common factor while MCAT Quantitative and MCAT Science were measuring unique second and third factors.
3) Pre-WSUSOM variables were moderately related to Biennium 1 GPA (.52 correlation for MCAT Science, .50 for Undergraduate GPA, and -.40 for age), but there were no significant correlations between pre-WSUSOM variables and clinical clerkship performance (i.e., Year 3 GPA). These findings indicate that premedical variables were more predictive of classroom achievement than of clinical performance.
4) For the most part, age was negatively correlated with academic performance with significant values appearing for Undergraduate GPA, MCAT Science, Biennium 1 GPA, and five National Board Part I scores. (In this case, a negative correlation means that as age increased, the related variable--e.g., MCAT Science--decreased. Or conversely, as age decreased, the related variable increased).
5) The .78 correlation between Biennium 1 GPA and Year 3 GPA was larger than anticipated suggesting that Year 3 clerkship programs may be evaluating students using some of the same procedures as their Biennium 1 colleagues (e.g., assessment of knowledge by means of paper-and-pencil tests). In addition, it suggests a higher degree of interest and discrimination than can be found in many medical school clinical evaluation procedures.

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[1]Data analysis was performed with the Statistical Analysis System (Cary, North Carolina: SAS Institute, 1980).

[2]The Classes of 1980 and 1981 were administered the Old MCAT with its four subtests. Starting with the Class of 1982, the New MCAT with its six scores has been administered. While precise parallelism does not exist between the two MCATs, the reader can relate the two tests in that they both measure aptitude for medical school academic work. Thus, the Old MCAT should not be discounted by those wanting to apply the findings from this study.

With regard to correlations involving National Board examinations, the following relationships are noteworthy:

1) Undergraduate GPA was a better predictor of National Boards Part I than of National Boards Part II.
2) Of the four MCAT scores, only MCAT Science showed promise as a predictor of National Boards Part I. The MCAT scores were slightly better predictors of National Boards Part II.
3) National Boards Part I discipline exams were highly intercorrelated with the exception of Behavioral Science, which was more moderately correlated with other Part I exams.
4) Fairly high intercorrelations among Part II discipline exams were evident except for Preventive Medicine/Public Health and Psychiatry, which yielded somewhat lower intercorrelations. Medical educators might speculate as to what is unique about Behavioral Science, Preventive Medicine/Public Health, and Psychiatry which contribute to the inability of these three disciplines to correlate well within their respective parts of the National Boards.
5) Moderate to strong correlations were evident between Part I and Part II discipline exams with Pathology showing particular strength when correlated with Part I disciplines.

Multiple regression analysis was performed to find which combination of the nine pre-WSUSOM and WSUSOM variables best predicted National Boards Part I Average and National Boards Part II Average. Table 3 shows that 66.1 percent of the variance in National Boards Part I Average can be predicted with the use of Undergraduate GPA, MCAT Quantitative, and WSUSOM Cumulative GPA. MCAT Verbal, MCAT Quantitative, and WSUSOM Cumulative GPA can be used in combination to predict 72.8 percent of the variance in National Boards Part II Average.

With regard to the contingency table data reported in Tables 4 through 11, the characteristics of the data (e.g., small expected frequencies) prevented the application of inferential statistical tests. However, an exploratory quasi-statistical analysis was performed. In making comparisons, a difference of 20 percent was considered noteworthy, less than 20 percent represented no difference.

The findings were as follows:

1) A graduate from a nonurban hometown[3] was more likely to do a southwestern Ohio residency (80% chance--4 of 5) than a graduate from an urban hometown (53.8% chance--14 of 26). See Table 4.
2) There was no difference between a nonurban graduate and an urban graduate in likelihood of doing an Ohio residency (80%--4 of 5 for nonurban; 73.1%--19 of 26 for urban). See Table 5.
3) There was no difference between a nonurban graduate and an urban graduate in likelihood of choosing a primary care specialty[4] (80%--4 of 5 for nonurban; 65.4%--17 of 26 for urban). See Table 6.
4) There was no difference between a nonurban graduate and an urban graduate in likelihood of choosing the specialty of family practice (60%--3 of 5 for nonurban; 42.3%--11 of 26 for urban). See Table 7.
5) An older graduate (age 23 or more at WSUSOM matriculation) was more likely than a younger graduate (less than 23 at WSUSOM matriculation) to do a southwestern Ohio residency (70%--14 of 20 for older graduates; 36.4%--4 of 11 for younger graduates). See Table 8.
6) There was no difference between younger and older graduates in likelihood of doing an Ohio residency (63.6%--7 of 11 for younger; 80%--16 of 20 for older). See Table 9.
7) There was no difference between younger and older graduates in likelihood of choosing a primary care specialty (63.6%--7 of 11 for younger; 70%--14 of 20 for older). See Table 10.
8) An older graduate (55%--11 of 20) was more likely than a younger graduate (27.3%--3 of 11) to choose the specialty of family practice. See Table 11.

[3]The very small number of graduates from nonurban hometowns makes the first four findings highly speculative.

[4]Primary care specialties are family practice, pediatrics, and general internal medicine.

Logistic multiple regression analysis was performed for four dependent variables. Logistic multiple regression analysis permits the researcher to fit a prediction model when the dependent variable is not continuous. In this study the researcher investigated which independent variables of interest (Undergraduate GPA, MCAT Verbal, MCAT Science, MCAT Quantitative, MCAT General Information, WSUSOM Cumulative GPA, National Boards Part I Average, and National Boards Part II Average) were statistically significant predictors of four individual nominal dependent variables:

1. location of residency (southwestern Ohio or outside southwestern Ohio)
2. location of residency (Ohio or outside Ohio)
3. practice specialty (primary care or non-primary care)
4. practice specialty (family practice or not family practice)

Table 12 reports the findings.

For the first logistic multiple regression analysis, no independent variable was a significant predictor of location of residency (southwestern Ohio or outside southwestern Ohio). For the criterion location of residency (southwestern Ohio or outside southwestern Ohio) the predictive accuracy coefficient was .019 (where 1.00 is perfect prediction and 0.00 is the same as flipping a coin). Thus, the set of independent variables used has no ability to predict location of residency (southwestern Ohio or outside southwestern Ohio).

For the second logistic multiple regression analysis, one independent variable--National Boards Part II Average--entered the model as a statistically significant predictor ($p < .0023$) of location of residency (Ohio or outside Ohio). National Boards Part II Average accounted for 17.5 percent of the variance in the dependent variable--location of residency (Ohio or outside Ohio). The 8 graduates who chose out-of-state residencies had a mean National Boards Part II Average of 576.88 while the 23 graduates who chose Ohio residencies had a mean of 466.52. For the criterion of location of residency (Ohio or outside Ohio) the predictive accuracy coefficient was .392. Thus, in attempting to predict whether a graduate will do his/her residency in Ohio, National Boards Part II Average is a potentially useful independent variable, and as the size of the predictive accuracy coefficient (.392) indicates, National Boards Part II Average can be viewed as moderately useful for prediction purposes when Ohio/nonOhio residency is the criterion.

For the third logistic multiple regression analysis, no independent variable was a significant predictor of practice specialty (primary care or nonprimary care). For the criterion practice specialty (primary care or nonprimary care) the predictive accuracy coefficient was an insignificant .093. Thus, the set of independent variables used has no ability to predict practice specialty (primary care or nonprimary care).

For the fourth logistic multiple regression analysis (family practice or not family practice), one independent variable--MCAT Quantitative--entered the model as a statistically significant predictor ($p < .0013$) of practice specialty (family practice or not family practice). MCAT Quantitative accounted for 17.8 percent of the variance in the dependent variable--practice specialty (family practice or not family practice). The 14 graduates who chose family practice residencies had a mean MCAT Quantitative score of 543.57 while the 17 graduates who chose a residency other than family practice had a mean of 635.00. For the criterion of practice specialty (family practice or not family practice) the predictive accuracy coefficient was .248. Thus, in attempting to predict whether a graduate will choose a family practice residency, MCAT Quantitative is a potentially useful independent variable. The predictive accuracy coefficient of .248 suggests that MCAT Quantitative is somewhat useful in predicting whether a graduate will choose a family practice residency.

Discussion

For the first graduating class of the Wright State University School of Medicine (Class of 1980), statistical analyses were performed to investigate relationships among variables and the prediction of three WSUSOM objectives--ability to be licensed (as measured by National Board performance), practice of primary care medicine, and location in Ohio and more specifically southwestern Ohio. The analyses performed were (1) correlations among 24 quantitative variables; (2) multiple regression with National Boards Average Part I and Part II as dependent variables and nine independent variables; (3) contingency tables relating location of residency and type of practice with hometown and age at matriculation; and (4) logistic multiple regression with location of residency and type of practice as dependent variables and eight independent variables.

Educational program evaluation involves examining the degree to which goals are achieved. Educational development involves identifying and subsequently incorporating components and factors known to promote goal achievement. This study is the beginning effort of a young medical school to adopt the evaluation-development approach. By carefully and thoroughly examining relationships and predictors among its program goals, faculty and administrators will develop educational policies and practices which are more likely to be compatible with program goals.

The reader should be cautioned not to attach undue meaning to the results reported in the study. The findings hold for one class at one time period. Some findings may differ when investigated at subsequent times due to changes in the data. For example, as specialty choices change among graduates, predictors of specialty may also change. Furthermore, the Class of 1980 is atypical in that it is small (only 31 graduates) and a charter class. Charter classes frequently are selected and treated differently from subsequent classes and thus can be quite distinct from their colleagues who follow. This study is the first in a series which will (1) examine various classes longitudinally and (2) cross-validate findings from class to class and year to year. Through a collection of studies compliled over the years, reliable and valid conclusions can be drawn; however, a single study such as this investigation should be treated in a tentative manner.

TABLE 1: Means and Standard Deviations for Academic Variables
Class of 1980 (N = 31)

	Variable		
Pre-WSUSOM			
	1. Undergraduate GPA	3.48	.38
	2. MCAT Verbal	557.58	85.87
	3. MCAT Science	593.39	61.70
	4. MCAT Quantitative	593.71	87.82
	5. MCAT General Information	542.42	76.68
	6. Age at matriculation	24.74	3.33
WSUSOM			
	1. Biennium 1 GPA	2.83	.46
	2. Year 3 GPA	3.05	.36
	3. Cumulative GPA	2.94	.39
National Boards			
Part I	1. Anatomy	552.74	102.04
	2. Biochemistry	479.84	100.05
	3. Microbiology	481.77	114.70
	4. Pathology	518.87	96.11
	5. Pharmacology	479.19	92.06
	6. Physiology	508.39	80.54
	7. Behavioral Science	496.77	93.72
	8. Part I Average	501.94	99.21
Part II	9. Medicine	474.35	93.17
	10. Obstetrics/Gynecology	533.06	83.99
	11. Pediatrics	511.13	86.80
	12. Preventive Medicine/Public Health	489.52	88.17
	13. Psychiatry	468.55	93.46
	14. Surgery	501.61	109.02
	15. Part II Average	495.00	93.22

TABLE 2. Correlation Matrix for Academic Variables
Class of 1980 (N = 31)

+p ≤ 05
*p < 01

	UGGPA	MCATV	MCATSC	MCATQ	MCATGI	AGEMAT	BIGPA	YR3GPA	CUMGPA	NBANT	NBBCH	NBMICR	NBPATH	NBPHRM	NBPHYS	NBBEHS	NBPT1	NBMED	NBOBGY	NBPED	NBPMPH	NBPSYCH	NBSURG	NBPT2
UGGPA		.03	.37+	.10	.16	-.56*	.50*	.30	.41+	.50*	.49*	36+	.53*	.44+	.42+	.21	.52*	.29	.40+	.30	10	.31	.26	.34
MCATV			-.02,	.07	.74*	.35	.25	.23	.26	.16	.18	.12	.32	.10	.13	.42+	.23	.24	.21	.31	.35	.49+	.32	.39+
MCATSC				.23	-.07	-.37+	.52*	.28	.43+	.43+	.32	.32	44+	.41+	.40+	.19	.43+	.47*	.28	.28	38+	.26	.23	.39+
MCATQ					.07	05	,02	-.12	>01	.28	.09	.01	.14	.16	.28	.06	.17	.02	.21	-.09	.30	.23	.15	.16
MCATGI						.11	.22	.20	.24	.24	.34	.18	.34	.27	21	.30	.32	29	.18	.31	.31	.45+	.25	.36+
AGEMAT							-.40+	-.18	-.32	-.37+	-.28	-.43+	-.37+	-.40+	-.34	-.16	-.41+	-.31	-.21	-.27	.13	.04	-.14	-.16
BIGPA								.78*	.95*	.70*	.65*	.74*	.89*	.74*	.74*	.66*	.86*	.73*	.71*	76*	.45+	.56*	.64*	.78*
YR3GPA									.93*	.37+	.37+	.47+	.69*	.48*	.44+	.57*	.56*	55*	.74*	.75*	.46+	.55*	.67*	.75*
CUMGPA										.57*	.53*	.67*	.84*	66*	.65*	.66*	.77*	.68*	.76*	.79*	.50*	.59*	.70*	.82*
NBANT											.77*	.58*	.70*	.74*	.72*	.35	.84*	.61*	.50*	.52*	.32	.31	.61*	60*
NBBCH												.64*	,73*	.71*	.64*	41+	.85*	.58*	.49*	.45+	.20	.22	.46+	.50*
NBMICR													.82*	.81*	.75*	.43+	.86*	.69*	.52*	.51*	.21	.31	.55*	.37*
NBPATH														.82*	80*	.56*	92*	.77*	.76*	75*	.43+	.55*	65*	.80*
NBPHRM															.77*	.38+	90*	.77*	.58*	.61*	.36+	.38+	.54*	.67*
NBPHYS																.49*	.88*	.62*	.50*	.44+	.52*	.53*	.38+	.61*
NBBEHS																	.58*	.26	.50*	.52*	53*	.48*	.39+	54*
NBPT1																		.75*	.65*	.64*	.41+	.45+	.61*	72*
NBMED																			.61*	.74*	.42+	.47*	.68*	.81*
NBOBGY																				.78*	.47*	.60*	.77*	.86*
NBPED																					.54*	.58*	.73*	.89*
NBPMPH																						.72*	.45+	.73*
NBPSYC																							.51*	.77*
NBSURG																								.85*
NBPT2																								

Legend

UGGPA	Undergraduate Grade Point Average	CUMGPA	Cumulative Grade Point Average (WSUSON)	NBPT1	National Boards Average Part I
MCATV	Medical College Admission Test Verbal	NBANT	National Boards Anatomy	NBMED	National Boards Medicine
MCATSC	Medical College Admission Test Science	NBBCH	National Boards Biochemistry	NBOBGY	National Boards Obstetrics/Gynecology
MCATQ	Medical College Admission Test Quantitative	NBMICR	National Boards Microbiology	NBPED	National Boards Pediatrics
MCATGI	Medical College Admission Test General Information	NBPATH	National Boards Pathology	NBPMPH	National Boards Preventive Medicine/Public Health
AGEMAT	Age at matriculation	NBPHRM	National Boards Pharmacology	NBPSYC	National Boards Psychiatry
BIGPA	Biennium 1 Grade Point Average	NBPHYS	National Boards Physiology	NBSURG	National Boards Surgery
YR3GPA	Year 3 (Clinical Clerkship) Grade Point Average	NBBEHS	National Boards Behavioral Science	NBPT2	National Boards Average Part II

TABLE 3: Multiple Regression Analysis
Class of 1980 (N = 31)

Criterion	Predictors	Percent of Criterion Variance Accounted for by Predictors
National Boards Part I Average	Undergraduate GPA MCAT Quantitative WSUSOM Cum GPA	66.1
National Boards Part II Average	MCAT Verbal MCAT Quantitative WSUSOM Cum GPA	72.8

TABLE 4

Southwestern Ohio Residency

Hometown	Yes	No	Total
Urban	14	12	26
Nonurban	4	1	5
TOTAL	18	13	31

TABLE 5

Ohio Residency

Hometown	Yes	No	Total
Urban	19	7	26
Nonurban	4	1	5
TOTAL	23	8	31

TABLE 6

Primary Care Specialty

Hometown	Yes	No	Total
Urban	17	9	26
Nonurban	4	1	5
TOTAL	21	10	31

TABLE 7

Family Practice Specialty

Hometown	Yes	No	Total
Urban	11	15	26
Nonurban	3	2	5
TOTAL	14	17	31

TABLE 8

Southwestern Ohio Residency

Age at matriculation	Yes	No	Total
Less than 23	4	7	11
23 to 27	10	4	14
More than 27	4	2	6
TOTAL	18	13	31

TABLE 9

Ohio Residency

Age at matriculation	Yes	No	Total
Less than 23	7	4	11
23 to 27	11	3	14
More than 27	5	1	6
TOTAL	23	8	31

TABLE 10

Primary Care Specialty

Age at matriculation	Yes	No	Total
Less than 23	7	4	11
23 to 27	10	4	14
More than 27	4	2	6
TOTAL	21	10	31

TABLE 11

Family Practice Specialty

Age at matriculation	Yes	No	Total
Less than 23	3	8	11
23 to 27	9	5	14
More than 27	2	4	6
TOTAL	14	17	31

TABLE 12: Logistic Multiple Regression Analysis, Class of 1980 (N = 31)

Criterion	Predictor(s)	Percent of Criterion Variance Accounted for by Predictor(s)	Predictive Accuracy Coefficient
Location of residency (southwestern Ohio or outside southwestern Ohio)	none	----	.019
Location of residency (Ohio or outside Ohio)	National Boards Part II Average ($p < .0023$)	17.5	.392
Practice specialty (primary care or nonprimary care)	none	----	.093
Practice specialty (family practice or not family practice)	MCAT Quantitative ($p < .0013$)	17.8	.248

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